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— Legend —

Permanent Region or Native Breeding Grounds, where the species is always found in greater or less abundance.

Subpermanent Region, which the Species frequently invades, in which it can perpetuate itself for several years, but from which it in time disappears.

Temporary Region, or that only periodically visited and from which the Species generally disappears within a year: the extreme northern portion partakes more, however, of the Subpermanent Character.

Course of flight from Permanent Region.

Return flight from Temporary Region.

MAP

SHOWING THE DISTRIBUTION,

MIGRATION, PERMANENT AND SUBPERMANENT

BREEDING GROUNDS

— OR, —

AND REGION PERIODICALLY VISITED

BY THE

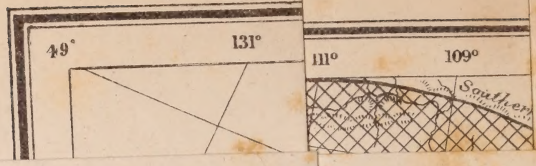
ROCKY MOUNTAIN LOCUST,

(CALOPTENUS SPRETUS).

Prepared by the

U.S. ENTOMOLOGICAL COMMISSION.

— 1877 —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DEPARTMENT OF THE INTERIOR.
UNITED STATES GEOLOGICAL SURVEY.
F. V. HAYDEN, U. S. GEOLOGIST-IN-CHARGE.

FIRST ANNUAL REPORT

OF THE

UNITED STATES

ENTOMOLOGICAL COMMISSION

FOR

THE YEAR 1877

RELATING TO THE

ROCKY MOUNTAIN LOCUST

AND

THE BEST METHODS OF PREVENTING ITS INJURIES AND OF GUARDING AGAINST ITS INVASIONS, IN PURSUANCE OF AN APPROPRIATION MADE BY CONGRESS FOR THIS PURPOSE.

WITH

MAPS AND ILLUSTRATIONS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1878.

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LETTER OF TRANSMITTAL.

OFFICE OF THE UNITED STATES
GEOLOGICAL SURVEY OF THE TERRITORIES,
Washington, D. C., February 2, 1878.

SIR: I have the honor, in behalf of the Commissioners, to transmit to you the first annual report of the United States Entomological Commission for the year 1877. This Commission, consisting of three skilled entomologists, was authorized by act of Congress approved March 3, 1877, to report upon the depredations of the Rocky Mountain locusts in the Western States and Territories, and the best practicable method of preventing their recurrence or guarding against their invasions, and was attached to the United States Geological and Geographical Survey of the Territories under my charge.

The Commissioners at once began their work upon receiving their appointments. Several thousand circulars asking for information were sent to persons in the locust area, and two bulletins in pamphlet form were issued, one containing full information regarding the preventive measures and direct remedies then known against the young locusts, for immediate use by farmers; the second containing an account of the habits of the locust, so far as then known, with numerous illustrations.

The field work was so subdivided as best to promote the end in view. It was carried on from early in April until the early part of November.

Mr. Riley was in the field and among the farmers in the more southern portions of the locust region, at those seasons when his services and observations were of most benefit. He went in April to Texas, and devoted most of the month of May to Southwest Missouri and Kansas. He visited Iowa in June, examining parts of Northwest Missouri and portions of Kansas and Nebraska. The month of July was spent by him in Colorado, and most of August and part of September in British America. In October he again spent some time in Kansas, and again visited Texas in November.

Mr. Packard, late in May, started for Wyoming and Utah, spending a few days in Colorado, and in June passed through Idaho and Montana, from Franklin to Fort Benton, thence down the Missouri River to Bismarck, and through Dakota to Saint Paul, Minn. He was, in August and September, in the Western Territories, and was in Utah and Nevada at the time when the people were suffering from the locusts, and afterward made a journey through Northern California, Eastern Oregon, and Washington Territory, so as to ascertain the western limits of the distribution of the Rocky Mountain locust. He, also, with the aid of observers in California, determined, with tolerable certainty, the species which have, for two centuries past, locally ravaged Oregon and California.

Mr. Thomas investigated the ravages and migrations of the locust in Iowa, Nebraska, and Minnesota, making three different trips to these sections for this purpose.

The great practical importance of an exhaustive study of this destructive insect throughout all the immense extent of the locust area, which lies between the 94th and 120th meridian, embracing nearly two million square miles, may be realized from the fact that on a careful estimate from all the data obtainable the States and Territories lying west of the Mississippi and east of the great plains suffered by the depredations of the locusts an aggregate loss, in the destruction of crops alone, during the years 1874–'77, of $100,000,000, to say nothing of the indirect loss by stoppage of business and various enterprises, which must have been fully as much more, thus making the direct and indirect loss not less than $200,000,000. In addition to all this we must include as

a part of the effect of locust injuries the checking of immigration and the depreciation in the value of lands. So depressing, in fact, was this result in some regions as to paralyze trade, put a stop to all new enterprises, and dishearten the communities where the suffering was greatest. I have every evidence that the work of the Commission already done has directly saved the small amount originally appropriated more than a hundred fold. Besides this it was indirectly beneficial by its encouraging predictions as to the future, which were fully verified, and by the recommendations made, which restored a good degree of confidence and had much to do in inducing emigration westward. The very encouraging conclusions of the Commission as to the prospects the present year and for some years to come will also continue to exert a most beneficial effect on the West. The predictions of the Commission, which are on record in the introduction to the report, were verified to a remarkable degree, as the events of the year proved.

When we remember that to this day comparatively little is known of the source, movements, and management of the locusts that have for ages devastated the countries of the Old World, our government may well feel proud of the light that in a single year has been thrown on all these questions so far as our own destructive species is concerned.

Still, much remains to be done by the Commission. Further surveys need to be made of the permanent breeding-grounds in the Northwestern Territories; more facts are needed to perfect our knowledge of the migrations in this area; the co-operation of our government with Canada is needed to work up the subject properly in the locust region north of the United States boundary-line, and some other problems remain to be solved. When this is accomplished I believe that it will be possible at least to greatly modify or lessen these invasions and diminish the losses resulting therefrom, if not entirely prevent them.

The Commission therefore ask for another appropriation of $18,000 in order to complete this special investigation and to present to Congress a second and final report that shall evince the wisdom and economy of the national government in causing the investigation to be made, and shall bear practical results commensurate with the interests to the agriculture of the West involved. It is also contemplated to spend a portion of the time, when not in the locust area, in studying the habits and ravages of the cotton-worm of the Southern States. This can be done without interfering with the locust work, provided the full amount of the appropriation asked for be made.

It is believed that all such investigations of our more injurious insects will result in the saving of a large proportion of the annual losses to the country from insect pests, which are estimated to amount annually to $200,000,000; and it seems prudent and wise to take such steps as shall result in an abatement of the evil.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. CARL SCHURZ,
Secretary of the Interior.

LETTER OF SUBMITTAL.

WASHINGTON, D. C., *February* 1, 1878.

DEAR SIR: We herewith submit our first Report, to be by you transmitted to the Secretary of the Interior. As the Report shows, the larger part of the summer season was spent in active field-work; yet this formed but a small part of the labor of the Commission, each member of which was much engaged in attending to an extensive correspondence, and in conveying information to individuals seeking it. Aside from the experiments made and recorded in different parts of the Report, we have studied the transformations, from the egg to the adult, of quite a number of the more common locusts that occur east of the Mississippi. The results of these studies, as also of the more elaborate researches on the embryology of the locust, have been excluded from the present volume, in order not to delay its publication, and because they may more appropriately be given in special memoirs.

The creation of this special commission was but an expression of the public demand for more light on the locust problem, which was to a great degree involved in darkness and mystery. Investigation was called for because it was felt how little of a definite and satisfactory nature was generally known on the subject.

Entering the field with a full sense of the magnitude of the work, and with some misgivings as to the final outcome of our investigations, the difficulties that at first seemed insurmountable have either dwindled or entirely disappeared; and we point with some pride to the facts and discoveries embodied in our Report.

A year has not yet passed since receiving our appointments; yet within that time we have been able to establish the more important laws by which the insect is governed, and to bound, with a degree of accuracy that we had scarcely dared hope for, the permanent breeding-grounds whence the disastrous swarms emanate, and which before were almost unknown.

The danger of total destruction to crops that threatened the West at the time the Commission was appointed was safely passed, and in the event of its recurrence we have faith that, as a record of what has been and a guide to what may be done in future, this Report will, if judiciously distributed, enable the farmers to brave it again.

The young insects as they occur in the more fertile States affected can be mastered, as the Report will, we hope, abundantly prove. We point out the way, also, which we have every reason to believe will prove feasible and practicable, to prevent future incursions of the winged swarms.

While it has been the object of the Commission to cover as much ground as possible, so as to make this annual report as full and reliable as the time would permit, there yet remain several important subjects that it has so far been impossible to properly and exhaustively study.

The territory affected is so vast, embracing about 2,000,000 square miles, that much of it was imperfectly explored, especially in the Northwest. Mr. Riley had to cut short his investigations in British America both for want of time and want of funds. For similar reasons, and on account of Indian troubles, Montana, Wyoming, and Dakota have been but superficially explored.

The year 1877 was an abnormal year, *i. e.*, the winged insects had the previous year overrun and laid eggs in a large section of country in which the species is not indigenous, and a numerous progeny hatched in such country the past spring. This was most fortunate for many reasons, and it enabled the Commission to carefully study the

insects in this their unnatural condition, and to carry on experiments with a view of learning how best to control them. Much of the work of the Commission was with these young insects. The losses sustained through the devastations of the pest by a young and struggling frontier population, ill able to bear them, were immense, and there was so much discouragement that hundreds and thousands of persons were on the point of abandoning their new homes. At this juncture the Commission went into the field, and, by its encouraging predictions and recommendations, did much to inspire the people with hope and confidence, and greatly helped to draw westward again the emigration that had stopped.

All this work, however, interfered with needed investigation into the proper range and native home and breeding-grounds, and some other important questions which can only be properly studied during a normal year, *i. e.*, one in which the insect is confined to its native or permanent breeding-grounds. Such a year will be the present (1878), for from our investigations we are able to state with confidence that the people of the more fertile country west of the Mississippi, occasionally termed the border States, will not be troubled with the young insects next spring and summer, and probably not for several years to come.

It is therefore quite important that the investigations be continued until every question is settled that human investigation can settle.

For the proper settlement of some of the questions, the co-operation of the Dominion Government is desirable, and has been promised. The work should be made so thorough as to obviate any necessity in future years of creating another commission for the same purpose, and we are desirous of making it thus thorough.

There are various other insects of national importance of which much has yet to be learned, and, in addition to completing the locust investigation, the Commission propose, during the coming year, with proper aid from Congress, to study and report on some of these worst enemies of our agriculture. They are especially desirous of reporting on the Cotton Worm and other cotton insects of the South, which, though often so disastrous to the cotton crop, have never been fully studied, and as to the mere natural history of which there are yet many mysteries and conflicting theories.

Much has yet to be done in giving practical form to the conclusions arrived at and plans proposed by the Commission, to enable the work already done to bear proper fruit. To bring about the needed co-operation of the two governments, to cause proper laws to be enacted in all the States interested, and to inculcate the truths that alone will make the farmer master of the situation, is largely the work of the future.

In concluding this brief letter, permit us to sincerely thank you for your hearty co-operation and aid, without which we should have lost much valuable time in necessary work at Washington, and to which we are largely indebted for whatever success has crowned our efforts.

We have the honor to remain, yours, respectfully,

C. V. RILEY.
A. S. PACKARD, Jr.
CYRUS THOMAS.

To Dr. F. V. Hayden,
United States Geologist.

PREFACE.

This report is the more immediate result of the first year's work of the Commission, and is respectfully submitted for the benefit of the farmers of the West, who have so sorely suffered from the injuries inflicted by the insect of which it treats. The Commissioners hope and believe that it will form an invaluable record, for future reference and use, of all that is at present known of so important a subject.

Our work was ordered primarily for the benefit of the farmers of the locust-stricken country, and we have endeavored to present with greatest prominence those features of the subject most important from the practical and economic stand-point. There is, however, matter of a more or less scientific and technical nature invariably connected with investigations like that we are charged with, and the report would, in our judgment, be incomplete were such matter omitted. In order to better enable the reader who cares little or nothing for such technical details to pass over them, they are printed in smaller type than the text.

We have divided the locust area into three regions, which we have called, respectively, the *Permanent*, the *Subpermanent*, and the *Temporary*. As these terms will be frequently used for the sake of precision and conciseness in the body of the Report, we here call the attention of the reader to Map 1, on which they are represented.

In order to prevent the volume from becoming too bulky, we have been obliged to shorten some of the concluding chapters, and to omit entirely an elaborate bibliography of locust literature in other countries, prepared for us by Mr. B. P. Mann, of Cambridge, Mass., as also a descriptive paper on the locusts of the Pacific slope, by Mr. S. H. Scudder.

Much interesting material in the form of classified replies to circulars, detailed data used in making up the Report, and the work of special assistants, is relegated to a series of appendices at the end of the volume. These are paginated separately in brackets, with a view of hastening the printing of the Report, and they are arranged numerically to facilitate reference, as the different parts will frequently be alluded to in the body of the work by means of corresponding numbers in parentheses. In these appendices will also be found a list of correspondents (App. 26), who have, in one way or another, assisted the Commission. These are given by States, with the post-office addresses arranged alphabetically, in order to avoid the constant repetition of full names in the different classified replies to circulars. The insect drawings for the woodcuts have been made from life, many of them by Mr. Riley, some of them by

Mr. J. H. Emerton, of Salem, Mass., and a few by Mr. J. S. Kingsley, of the same place. They are generally larger than life, but the natural size is indicated by hair-line or outline, except with such more highly magnified details of special parts as have the natural size already indicated by the other figures. The anatomical drawings were made by Mr. Emerton from preparations by Mr. Packard, and the histological illustrations by Mr. C. S. Minot. The lithographic plates (I to IV) were either drawn by Mr. Riley, or by Mr. Emerton under his direction. The dimensions are expressed either in inches and the fractional parts of an inch, or (of the more minute objects) in millimeters—1 millimeter (1^{mm}) not quite equaling 0.25 inch. The sign ♂, wherever used, is an abbreviation for the word "male," and the sign ♀ for "female." The three maps were prepared by Mr. Packard.

The Commissioners take this occasion to thank the numerous correspondents and others who have aided in the work, and to acknowledge their indebtedness to the managers of the following railroads for the favor of passes over their respective lines:

Southern Michigan and Lake Shore; Chicago, Rock Island and Pacific; Chicago, Milwaukee and Saint Paul; Western Union; Northern Pacific; Saint Paul and Sioux City; First Division Saint Paul and Pacific; Saint Paul and Pacific; Missouri, Iowa and Nebraska; Sioux City and Pacific; Chicago and Northwestern; Keokuk and Des Moines; Des Moines and Fort Dodge; Chicago, Burlington and Quincy; Central Railroad of Iowa; Kansas Pacific; Kansas City, Saint Joseph and Council Bluffs; Missouri River, Fort Scott and Gulf; Saint Joseph and Denver; Missouri, Kansas and Texas; Atchison, Topeka and Santa Fé; Burlington and Missouri River, in Nebraska; Denver and Rio Grande; Texas and Pacific; Saint Louis, Iron Mountain and Southern; International and Great Northern; Missouri Pacific; Saint Louis and San Francisco; Saint Louis, Vandalia, Terre Haute and Indianapolis; Ohio and Mississippi; Illinois Central; Galveston, Harrisburg and San Antonio; Leavenworth, Lawrence and Galveston; Denver Pacific; Union Pacific; Atchison and Nebraska.

They also take this means of acknowledging the courtesy and encouragement received from the executives of the several Western States more particularly concerned, and the assistance given by the Signal Bureau; also the good services of the several special assistants employed, and particularly to Mr. Allen Whitman, of Saint Paul, Minn., to Prof. Samuel Aughey, of Lincoln, Nebr., and to Mr. Theo. Pergande, who faithfully assisted in office-work at the headquarters.

INTRODUCTION.

The injury by the Rocky Mountain locust to the agriculture, and, as a consequence, to the general welfare of the States and Territories west of the Mississippi, had been so great during the years 1873, 1874, 1875, and 1876, as to create a very general feeling among the people that steps should be taken by Congress looking to a mitigation of an evil which had assumed national importance. This feeling found expression, during the year last mentioned, in various memorials to Congress, one of the most important and cogent of which was that from a conference of the governors of various Western States and Territories, held at Omaha, Nebr., on the 25th and 26th of October, 1876. This memorial prayed for the creation of a commission of five experts to thoroughly investigate the subject, and an appropriation of $25,000.

The United States Entomological Commission was created in pursuance of an act of Congress appropriating $18,000 to pay the expenses of three skilled entomologists to be attached to Dr. F. V. Hayden's United States Geological and Geographical Survey of the Territories, and to report upon Rocky Mountain locusts, with a special view as to the best practicable method of preventing the injuries from these insects, and of guarding against their invasions. The Secretary of the Interior appointed Mr. Charles V. Riley, of Saint Louis, Mo., as chief, Mr. Cyrus Thomas, of Carbondale, Ill., as disbursing-agent, and Mr. A. S. Packard, jr., of Salem, Mass., as secretary. Upon receiving their appointments, the Commissioners at once met in Washington for the purpose of organization. The following record from the minutes of this first meeting indicates the scope of the work undertaken by the Commission, and the field which each member thereof was more particularly to occupy:

Division of labor.—Voted that the locust-area be divided into three regions, to each of which a Commissioner be assigned, as follows:

To C. V. Riley, the region east of the Rocky Mountains and south of the 40th parallel, the western half of Iowa, and, conjointly with Mr. Packard, British America west of the 94th meridian.

To A. S. Packard, jr., Western Wyoming, Montana, Utah, Idaho, and the Pacific coast.

To Cyrus Thomas the portion north of Riley's region, including the eastern half of Wyoming, Northern Colorado, the southern and eastern part of Dakota, Nebraska, eastern half of Iowa, and Minnesota. [Northwestern Iowa was subsequently added.]

To Mr. Riley were assigned Biology, or Natural History, Invertebrate Enemies and Parasites (Insects, &c.), Remedies and Devices for the Destruction of the Locust.

To Mr. Packard, Anatomy and Embryology.

To Mr. Thomas, Geographical Distribution, Enemies not Entomological, Agricultural Bearings of the Subject.

To Packard and Thomas conjointly, Connection of Meteorological Phenomena with the Migrations.

It was also decided that the publications should consist of circulars, bulletins, memoirs, and the annual report of doings and results of the work of the Commission, and that Mr. Riley should at once prepare the

bulletins, to contain a digest of the habits and best means of destroying the locust, for immediate circulation. It was also agreed that by interchange of data collected and consideration of each others' work by the Commission as a whole, the publications be made, as far as possible, conjoint.

On the 22d of March, 1877, the preliminary plan of action was submitted to the Secretary of the Interior, and, as it met with his approval, the members separated to begin work in the field as quickly as possible, since the young locusts were already hatching and doing damage in Texas and southerly regions. It was decided to have a merely nominal office at Washington, and that the headquarters of the Commission should be at Saint Louis, on account of the more central location of this city, and its greater proximity to the locust-region.

The following circulars, issued a few days afterward, explain themselves:

CIRCULAR No. 1.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE UNITED STATES ENTOMOLOGICAL COMMISSION,
———, ———, 187 .

Mr. ——— ———.

DEAR SIR: The Commissioners are desirous of collecting, as soon as possible, all ascertainable facts in reference to the migrations of the Rocky Mountain locust (*Caloptenus spretus*), and also regarding its appearance, habits, and devastations in your section.

We present below a series of topics upon which we shall be glad to receive data from your locality. We expect you to dwell only on those topics upon which you have positive information, and shall be glad to receive any facts or views not suggested by this circular. Some of the subjects cannot be reported on till toward the approach of winter, while others can be considered earlier. In responding, therefore, we ask our correspondents to couple their answers with the number of the circular and of the inquiry.

We shall be glad to receive and will determine any of the different species of locusts that occur in your locality, and particularly specimens of their different parasites and natural enemies. These are best forwarded by mail, packed in cotton, moistened with alcohol, and placed in secure tin or wooden boxes. Living specimens may be sent in tin boxes, and are preferred, where they will not be too long on the way.

The inquiries have reference more particularly to the present year 1877, and when facts are communicated that have reference to other years, correspondents will please be careful to specify the particular year.

The Commissioners will refund whatever expense may be incurred for postage in replying to this circular, or in forwarding specimens, should correspondents so desire.

Copies of documents published by the Commission will be sent to correspondents who forward data in accordance with this request. Communications may be sent to either of the Commissioners.

CHAS. V. RILEY.
A. S. PACKARD, JR.
CYRUS THOMAS.

TOPICS ON WHICH DATA ARE REQUESTED.

1. Date and time of day of the arrival of swarms.
   1*a*. Direction and force of the wind at the time.
   1*b*. Temperature and character of the weather at the time (clear or cloudy).
   1*c*. Direction of the flight, density, height, and extent of the swarms.

2. Date and time of day of the departure of swarms.

2*a*. Direction and force of the wind at the time.

2*b*. Temperature and character of the weather at the time.

2*c*. Direction of the flight, density, and extent of the swarms.

3. Date when the first eggs, if any, were deposited the present year.

4. Date when the eggs were most numerously hatching the present year.

5. Date when the eggs were most numerously hatching in previous years.

6. Proportion of eggs that failed to hatch the present year, and probable causes of such failure.

7. Nature of the soil and situations in which the eggs were most largely deposited.

8. Nature of the soil and situations in which the young were most numerously hatched.

9. Date at which the first insect acquired full wings.

10. Date when the winged insects first began to migrate.

11. Estimate the injury done in your county and State.

12. Crops which suffered most.

13. Crops most easily protected.

14. Crops which suffered least.

15. The prevailing direction in which the young insects traveled, and any other facts in relation to the marching of the young.

16. The means employed in your section for the destruction of the unfledged insects, or to protect crops from their ravages, and how far these proved satisfactory.

17. The means employed in your section for the destruction of the winged insects, or to protect crops from their ravages, and how far these have proved satisfactory.

18. Descriptions, and, if possible, figures of such mechanical contrivances as have proved useful in your locality for the destruction of either the young or the winged insects.

19. If your section was not visited in 1876, please state this fact.

20. If visited any previous years, please give the dates.

21. To what extent have birds, domestic fowls, and other animals, domestic or wild, been useful in destroying these insects.

22. State the ratio of prairie to timber in your section or in your county.

23. State all you know about the habits of the young or full-grown insects during the night, *and especially whether you have ever known them to march or continue to fly after the sun is down, and if so, how long into the night.*

24. The amount of damage to fruit and shade trees, and the most satisfactory means employed in your section to protect them.

CIRCULAR No. 2.

SAINT LOUIS, MO., ——— ———, 187 .

Mr. ——— ———:

DEAR SIR: With a view of securing co-operation, and of obtaining data in the particular divisions of the subject assigned to me, I beg leave to call your attention more particularly to the following topics, and ask your careful consideration of the same:

I. NATURAL HISTORY.—The natural history of the species has been already pretty thoroughly studied, so far as the development from the egg to the mature insect is concerned. Yet I shall be glad to have you communicate any facts or observations in your possession that you believe to be new or unrecorded. As to the habits of the species, there is more room for fresh observations, as the habits vary somewhat with locality, and my own studies have been mostly made in Missouri and Kansas. I would direct

your attention, therefore, under this head, more particularly to topics 12, 13, 14, and 15, of Circular No. 1, or, *crops which suffer most; crops most easily protected; crops which suffer least;* and *the prevailing direction in which the young insects travel* in your section, or any other facts in relation to the marching of the young. *Also, I desire all observations that are at all reliable as to the habits of both the young and the winged insects during the night, especially as to whether the latter have ever been known to continue flying after dark.*

While there may be little to add to what is now known of the natural history and habits of the Rocky Mountain locust (*Caloptenus spretus* Thomas), with which the Commission is more particularly concerned, there is much of interest yet to learn of the other species of locusts that are indigenous in your locality, and are often confounded with the *spretus*. Any facts as to the *habits, time and mode of depositing eggs, state in which the winter is passed, time of acquiring wings*, or, in short, any observations upon the native species, and more particularly those that are injurious, are earnestly desired by me. The observations should, as far as possible, be accompanied by specimens, and, indeed, I shall be glad to receive specimens of the different locusts or "grasshoppers" from your locality in different stages of growth. They may be killed either by dipping in hot water, by means of a little chloroform, or by throwing in alcohol; and should be mailed to me in stout wooden or tin boxes, packed in coarse sawdust or cotton previously moistened with alcohol. Living specimens, which are preferred, are best sent in tight tin boxes along with a small amount of appropriate food.

II. Insect enemies and parasites.—These will differ also, according to locality, and I shall be glad to receive specimens of all invertebrate animals that may be found preying either internally or externally on the locusts. Such specimens, when soft or small, are best preserved in alcohol, and mailed between two layers of cotton thoroughly saturated with alcohol, in a small and tight tin box. When larger they may be mailed as already indicated above. I respectfully solicit answers to the following questions:

1. What invertebrate animals are known to attack the locust-eggs in your locality, and to what extent have they destroyed the same?

2. What insect enemies attack, *first*, the young; *second*, the winged locusts; and what percentage of these have been destroyed by them?

3. State any facts that you know about the habits and transformations of the different parasites or other enemies observed.

III. Remedies.—Under this head I desire general reports on topics 16 and 17 of Circular No. 1. *First*, as to the means employed in your section for the destruction of the unfledged insects, or to protect crops from their ravages, and how far such means have proved satisfactory; *second*, the means employed against the winged insects, and how far they have proved satisfactory.

I would more particularly call your attention to the following points:

4. Has any application, either in powder or liquid, been used that protected special plants from locust ravages without injuring the plant?

5. Has harrowing of the eggs in the fall been resorted to, and with what effect; or have any other means been employed to expose or break open the egg-masses?

6. Where satisfactory results have followed the plowing under of the eggs, state the time of year of such plowing, the depth, and the nature of the soil.

7. Where ditching has been resorted to to protect fields from the inroads of the unfledged locusts, state the measure of success, the nature of the soil, and the character, particularly as to the depth and width, of the ditch.

If any measures not recommended by the Commission in its bulletins are or have been adopted, please specify them.

If you desire to test any special measure involving expense, where such test seems warranted by possible practical results, please correspond with me for further advice and instruction.

IV. Devices for destruction.—Under this head I desire reports as to the efficiency

and usefulness of such machines or other mechanical contrivances as have been tried and used in your section. Where any machine has proved useful I desire to obtain full plans and description of the same, and, where possible, illustrations. Where such have not already been drawn up or made, I will co-operate with inventors in getting the work done where it is thought desirable. So far as time will permit, I shall endeavor to personally examine and test such contrivances, and will assist to a full trial of them any inventor who communicates his plans.

Copies of documents published by the Commission will be sent to correspondents who forward data in accordance with these requests.

I have the honor to be, yours, respectfully,

CHAS. V. RILEY.

Some additional questions were sent out with Circular No. 1 by Mr. Thomas, and among them the following:

Furnish copies of all the records you can obtain, which were made at the time of the visitations of the grasshoppers, whether written or printed.

State all you may know in reference to eggs hatching in the fall.

What plants, cultivated or wild, appear to be preferred by the young, and what by the full-grown insects?

What plants, cultivated or wild, appear to be least relished?

State to what extent the invading swarms have been observed to injure the native grasses, and to what extent the young have been observed to injure them.

What animals, such as quadrupeds, birds, and reptiles, have been observed feeding upon the young or full-grown insects or their eggs?

State what measures for destroying the eggs have been tried, and how far they have proved effectual.

State the ratio of prairie to timber in your section.

State all you know in reference to the habits of the young or grown insects during the night; where they remain, whether they ever march, continue to fly, eat, &c.

At what rate do swarms move during flight?

Mr. Packard also issued a special circular, requesting, in addition to the information sought by Circular No. 1, special information west of the mountains, as follows:

CIRCULAR No. 3.

SALEM, MASS., *May* 15, 1877.

DEAR SIR: In behalf of the United States Entomological Commission I ask your aid in studying the habits, distribution, and extent of damage done, in past years as well as the present, by the locust or destructive grasshopper, in the department of the locust-area assigned to me, *i. e.*, Montana, Idaho, Western Wyoming, Utah, Oregon, Washington Territory, and California.

The main breeding-places of the locusts visiting the border States are situated in the Northwest. Information is especially desired concerning the breeding of locusts in the plains lying around the Black Hills, especially to the east and north; also in the valleys of the Platte, Yellowstone, Upper Missouri, Snake, and Columbia Rivers, and especially the treeless plains of Eastern Oregon and the eastern portion of Washington Territory. The locusts invading Utah in former years are supposed to have come from the Snake Valley to the northwest and north.

The said Territories, particularly Montana, Idaho, Wyoming, and Eastern Washington and Oregon, are so thinly settled that it will be difficult for me to obtain the post-office address of those who might be willing to co-operate with the Commission if they could receive our circulars and bulletins. These and other publications of the Commission will be sent to those answering in part or wholly the questions appended to this circular. Postmasters and others receiving this circular are respectfully requested

to send the address of any one who they think would thus co-operate with the Commission.

While locusts have not seriously ravaged the Pacific coast since 1855, it is very desirable for the Commission to ascertain whether it is the Rocky Mountain locust or some other species of grasshopper which has periodically devastated the coast for nearly two centuries past. For this purpose specimens from all parts of the States of California, Nevada, and Oregon, and Arizona and Washington Territories, are earnestly desired.

Please, therefore, send me specimens of any destructive grasshopper, as well as samples of all the different kinds of grasshoppers and crickets, their eggs, young, and parasites, in your town or county, so that I may be sure which species is referred to in your communication. They may be killed by hot water or soaked in alcohol a few hours, dried and packed between papers, in cotton or sawdust, in strong wooden or tin boxes, and mailed to me at Salem, Mass. It would be well also to keep a bottle of alcohol or whisky on hand into which specimens could be thrown from time to time. The bottle could be carefully packed and sent, at the end of the season, by express, to the headquarters of the Commission at Saint Louis, Mo.

Please inclose in all parcels and bottles a label giving date, town, county, and State or Territory, the name of collector, written with a black-lead pencil on stout letter-paper. Postage will, of course, be refunded, if desired. Trusting to receive your hearty co-operation in the objects of the Commission,

I remain, your obedient servant,

A. S. PACKARD, Jr.,
Secretary United States Entomological Commission.

Has your section ever been visited by invading swarms of grasshoppers? If so, name the years.

Please furnish copies of all the records you can obtain which were made at the time of the visitations of the grasshoppers, whether written or printed.

As will be seen by the classified replies in the appendix, much valuable information was obtained by means of the first general circular, but scarcely any on the special points in the others. This was to be expected, as the average farmer is in no position to carry out special investigations, which for their satisfactory completion require time, training, and proper appliances.

It is our intention, in this connection, to give a brief history of our field-work and of the locust phenomena of the season, but for full details regarding the year's occurrences in the different States the reader is referred to the chapter on chronology and to the appendices.

As will appear in the chapter just referred to, locust-eggs had been laid in 1876 over an extensive area, roughly defined by drawing a line from Breckenridge to Cheyenne, thence to the Taos Valley, thence to Houston, thence to Saint Paul, the eastern line deflecting westward in Missouri and Kansas. They were most thickly laid east of the 100th meridian, and the gravest apprehensions were naturally felt as to the injury that would result in the spring of 1877. The examination of eggs from time to time during the winter, from different parts of the area just defined, made it quite certain, as spring approached, that the majority of them would hatch; and as already intimated, the young insects were doing much injury in southerly regions by the time the Commission was created. Mr. Riley visited Texas in April, when the

locusts were doing their greatest damage, or just as the bulk of them were reaching the pupa state around Denison and Dallas, and the winged insects had commenced to fly from the more southern parts. About Houston considerable damage was done to young cotton, but here and about Galveston the country is devoted largely to grazing and was not so seriously affected. About Hutchins the farmers despaired of saving anything, and many fine settlements along the Texas Central and along the Galveston, Harrisburg and San Antonio Railways suffered severely. Around San Antonio large numbers of the insects were found by Mr. J. Boll, of Dallas, whom we employed as special assistant, and whose reports, with other details from this State, will be found in the appendix. (App. 3.)

Having during the winter, as entomologist of the State, thoroughly familiarized himself with the extent and condition of the eggs in Southwest Missouri, he spent but a brief period there early in the month; and while there was slight damage "in spots," the country suffered far less from the young insects than it had the previous autumn from their winged parents. (See App. 4.) The only counties in which the insects hatched at all in Missouri were: 1st, Atchison and Holt, and the western half of Nodaway and Andrew, in the extreme northwest corner. 2d, McDonald, Barry, Jasper, Lawrence, Barton, Dade, Newton, Cedar, Vernon, more particularly in the southwest half; Polk in the northwest third; and Hickory in the southwest third.

What is true of Missouri is also true of the limited area in the northwest corner of Arkansas; and while Mr. Riley had no time to visit Benton County, where the eggs had been most thickly laid, reports showed that the injury from the young insects was trifling. In passing through Indian Territory, along the M., K. & T. Railroad, no damage was noticed; and though the winged insects were thick enough in the Territory to render travel on horseback disagreeable the previous autumn, wild prairie and timber and grazing land so predominate over the cultivated area that the damage can never be great.

During the end of April and the early part of May, Mr. Riley was in the field in Kansas, traveling over the southeastern counties with Governor Anthony and Mr. A. S. Johnson of the Atchison, Topeka and Santa Fé Railroad. He found the people determined to resist the enemy, and in many cases well prepared and organized to do so. He appointed, with the co-operation of the governor, who partly defrayed their expenses, two assistants in this State, viz, Mr. A. N. Godfrey, of Manhattan, and Mr. G. F. Gaumer, of Lawrence. Their reports, with other data (App. 5), together with the following letters, will convey a correct idea of the condition of things in this State at the time:

STATE OF KANSAS, EXECUTIVE DEPARTMENT,
Topeka, May 5, 1877.

SIR: It is now impossible for me to join you in your tour of observation through the State, as promised. I feel a deep interest in the results of your examination, and have to urge upon you the importance of passing over as great a breadth of territory as

possible in the time you can give to this State. I desire from you, for publication, a statement of the true condition and prospects as you find them.

I have feared that the reports of addled eggs and disappearing insects are based on hope instead of facts. If so, they cannot fail to work injury by quieting the people with belief in a false security. If the eggs in the soil are still unhatched and in a condition to produce in destructive numbers when the weather is propitious, it is far better that the people know the worst and prepare for it without delay.

I am satisfied that a determined and systematic effort will exterminate the locust and save our growing crops, even if the worst be true as to the present hatching. An organization under the township law, or unanimity of volunteer action, with the means now known to be effective in the destruction of these insects, cannot fail of substantial success.

To this end I hope you will favor me with a full report of your tour of observation, together with such suggestions as to mode and time of destroying the locust, as your observation and experience shall warrant. This statement from you will be accepted as authentic by the great majority of our people, and will allay fear if there is no danger, and awaken to action if a pending peril exists.

Very respectfully,

GEO. T. ANTHONY,
Governor of Kansas.

Prof. C. V. RILEY,
Chief of United States Entomological Commission, Emporia, Kans.

SALINA, KANS., *May* 10, 1877.

MY DEAR SIR: Your favor of the 5th instant is before me. I am entirely of your opinion as to the importance of getting at the real facts and prospects in connection with locust injury. The dispatches to our papers are so often colored in the interest of land-owners, and loan and real-estate agents, that the community at large places but small reliance on them. It is, moreover, the avowed policy of many journals to suppress the truth about locust troubles, under the mistaken notion that such suppression benefits; whereas no policy is more injurious to a community in the end.

In the present instance the favorable reports are, in the main, warranted; and there is no doubt in my mind that throughout the larger part of Kansas the battle is already fought, and the future injury must be comparatively trifling. For nearly three weeks I have been traveling and observing in Texas and Southeastern Kansas, and feel safe in making the above statement for that part of your State which I have visited. Throughout the locust-area of the State south of the Kansas Pacific Railroad—which area includes most of the region bounded on the east by a line running from a little west of Lawrence toward Fort Scott, and on the west by another passing up through Hutchinson and Ellsworth—the eggs are laid in sufficient quantities to have given birth to locusts enough to have eaten everything green by the time they attained full growth, under conditions favorable to them. Many of the eggs were destroyed by the Anthomyia egg-parasite, and the other enemies described in my writings. Some of them hatched in the Fall, and many more during the warm weather of the latter part of January and fore part of February. The insects thus hatched perished. The bulk of the eggs hatched during the last week of March and the early part of April. The young insects were very thick then; they commenced to do injury and begat general fear. The farmers for the most part fought them with energy. Then followed, from the middle of April on, a period of cold and wet weather. The enemy rapidly weakened and was from all quarters reported as disappearing.

DISAPPEARANCE OF THE YOUNG.

In every part of the State which I have visited, and where I have examined carefully the condition of things, the young locusts have very largely, in some instances totally, disappeared; and I now have no doubt whatever that the reports of such disappearance that are so general throughout the entire portion of the State that was threatened, have their foundation in fact. This disappearance is generally attributed to

death and dissolution from the cold and wet weather that followed the principal hatching. That this weather has been largely instrumental in causing death among the hopping pests I have no doubt, because there are always a certain portion just hatched or just molting, which are particularly tender and susceptible to the injurious effects of cold, drenching rains. But they have been dying and are now dying fast during the present warm and sunny weather, and these dead insects are not parasitized, but simply diseased—sick. In my last (ninth) report made to the State of Missouri, in stating the causes that might diminish the prospective injury, I wrote:

We may therefore expect that, as compared with 1875, a larger proportion of the young that will hatch in 1876 will be weakly and soon perish. * * * There is a bare possibility that, after the bulk of the young have hatched, and before they have commenced to do serious harm, we may have such unseasonably cold and wet weather as to kill them by myriads, and effectually weaken their power for injury.

Both possibilities have become actualities.

It is a singular fact, however, that notwithstanding the large numbers which hatched, no one has been able to discover the dead carcasses of these disappearing locusts in anything like the numbers necessary to account for the disappearance; and, in most instances where dead insects have been reported to me, an examination at once showed that the parties had mistaken therefor the exuviæ or empty skins of those which had molted; which skins are always abundant under straw or weeds, or at the base of a wheat-stool, where the young insects congregate when undergoing their molts.

The young locusts possess remarkable tenacity of life, and the fact that the bulk of those remaining are in the third stage (*i. e.*, have molted twice) and must have hatched before the unfavorable weather set in, is in itself enough to show that other factors than those meteorological have entered largely into the problem of disappearance. The principal of these I will briefly enumerate, because, unlike meteorological or climatic influences, they may, most of them, be relied upon in future, are largely within man's control, and may even be rendered still more effective. They are, in short, elements of certainty in the problem of locust destruction.

First. *The natural Enemies of the Locust.*—These consist in the present instance (the parasites not affecting it till it gets older) of the vertebrate animals which are known to feed upon it, such as snakes, gophers, field-mice, &c., and birds. These last have been more efficient than most of us imagine, and I never saw blackbirds, plover, &c., so numerous. Their dung often whitens the fields where the locusts were once thick, and they have been the principal cause of the latter's disappearance. The prolonged cold and wet retarded the development of the insects, benefited the wheat, and gave our feathered friends an excellent opportunity to check them. We should employ all means to encourage the multiplication of the birds.

Second. *The Farmers.*—In most parts of the State I have traversed, the farmers had determined from the beginning to make war, and they did make war, and so successfully that the insects were pretty effectually destroyed before the cold and wet occurred. The means employed were mostly kerosene-pans and burning—over 700 kerosene-pans having been made at Salina alone.

Third. *The Weather.*—The continued cold after the principal hatching had the effect, as already stated, to kill many that were just hatching or molting. The heavy rains washed many away into the streams, and in some instances in soils which contain sand and lime, and which are liable to crack when dry, the rains doubtless covered up and killed such as were sheltering in such fissures.

Fourth. *Climate.*—The fact that the insects, especially after the second and third moltings, are dying, is simply confirmatory of the views I have always held and advanced, that the species is out of its natural habitat, and can never permanently thrive here. These views I need not now repeat at length. While the number that have thus become sickly and died have not so far begun to compare with those which have perished in the other three ways mentioned, it will doubtless continue to increase as the insects get larger, for already they show a tendency to unnaturally group together during the heat of the day, and feed much less ravenously than when in perfect health.

EXTENT OF THE FAVORABLE STATE OF THINGS.

Such are the generally favorable conditions throughout the area which I have already mentioned, and of which alone I can speak with assurance. How far the same conditions prevail north of the Kansas Pacific, and in the other States threatened, I cannot positively tell yet; but similar reports of disappearance are very general, and I am strongly of the opinion that we shall have a repetition of the comparative harmlessness of 1867.

VIGILANCE STILL NECESSARY.

I am the last to desire that this favorable report should lull your farmers into an undue sense of security. The security against injury will depend altogether on the proportion of eggs which have hatched. Thus in the more sandy belt west of a line roughly drawn through Junction City and Florence, not one per cent. of the eggs remain unhatched; while east of that line, where the eggs were laid later and the soil is mostly colder and more tenacious, from one-half to three-fourths of them are yet unhatched, and, with few exceptions, sound. In the former area a few fields may suffer, especially along the river-courses, but there will be no general destruction; in the latter the injury *may* yet be great, and should be provided against.

REMEDIES.

[Here followed a summary of remedies.]

CONCLUSION.

I have endeavored in the above hurried notes to comply with your request, and have necessarily left much of interest unsaid. Altogether, the prospect is much brighter than I had dared to hope. There is some apprehension from the winged insects that have been for some time leaving Texas, where little was done to fight the pest, and where much injury has occurred in spots, particularly from Denison southwestwardly. But in passing from the south, the injury done by the winged insects is never materially felt. They are unhealthy and less voracious, and the crops are well advanced. They also pass mostly over the western part of your State. Permit me to remark, in conclusion, that I have met with few persons who do not feel that if taken in time the young insects are easily mastered and need cause little alarm in future—a fact which I have long since insisted on, and which is generally admitted by all who have had experience. When the locust-scourge is fully understood, and the farmers unite in determined effort to counteract it, it will cease to be so much of a bugbear, and no longer interfere with the settlement of the beautiful and productive western plains which it visits at irregular intervals.

I have the honor to remain, yours, truly.

C. V. RILEY.

GEO. T. ANTHONY,
Governor of the State of Kansas.

We are under sincere obligations not only to Governor Anthony who so materially assisted us, but, among many others, to Mr. Alfred Gray, secretary of the State board of agriculture, for repeated favors and cooperation.

During the latter half of April and first part of May Mr. Thomas visited Minnesota, Northwestern Iowa, and Nebraska, devoting his attention at this time chiefly to an examination of the egg-deposits, the condition of the eggs, and the indications where the young were then hatching out. He also at this time made arrangements throughout the various sections of these States and Dakota with local observers, who were to note all important facts in their respective sections relating to the locusts, and report from time to time. Mr. Allen Whitman, of Saint

Paul, who had previously been employed by the State of Minnesota to report upon the history, habits, and injuries of the Rocky Mountain locust in that State, was engaged as assistant for that portion of the district. Prof. Samuel Aughey, of the State University at Lincoln, was engaged as assistant for that portion of the district. The valuable aid furnished by these two assistants will be shown by reference to their reports which will be found partly in the appendix (Apps. 1, 2 and 8) and partly incorporated in the text.

While in Minnesota Mr. Thomas prepared and issued the additional questions heretofore alluded to. He was also called upon to give his opinion in reference to the prospects of the season, and, gloomy as these appeared at the time, he did not hesitate to state as his conviction in various publications that the end of the trouble was drawing near. The executive of this State, Governor Pillsbury, entered heartily into the work of the Commission, giving it every encouragement and assistance in his power.

The following extract from a letter of Mr. Thomas's, published at the time in the Chicago *Inter-Ocean*, will give an idea of the locust-status as understood at that time in Minnesota and Dakota:

I have just visited the southwestern part of Minnesota, spending a short time in making inquiries and examinations in a few of the counties supposed to contain the heaviest deposits of eggs. In some localities, where the eggs were observed in great numbers last fall, but few were to be found in these places, as a general rule. I observed in considerable numbers certain coleopterous, hymenopterous, and dipterous larvæ, known as locust-egg destroyers. In other places, but a few miles distant, eggs were found in abundance, and mostly sound. The information, so far as ascertained in reference to this portion of Minnesota, agrees in the main with these observations, and thus explains the apparently conflicting reports received. These facts render it probable that, while it is true as a general rule that the locusts will hatch out over the greater portion of Southwestern Minnesota, yet many localities will be comparatively free from the young; in other words, the hatching will be uneven throughout this section, and will not be in proportion to the number of eggs deposited.

The bounty law will probably prove inoperative in the worst-infested counties, as the citizens of these counties feel certain it will entail a debt upon them which will require years to pay; hence they will not avail themselves of its provisions.

Hatching has already commenced as far north as Nicollet County, in the warmer situations, and as I passed southwest on the Saint Paul and Sioux City Road, I noticed the prairies in every direction were burning, for the purpose of destroying the young 'hoppers.

Several of the counties of this section lying near and along the western boundary of the State will probably escape serious injury, as but few eggs have been deposited in them. The young have hatched out in considerable numbers around Sioux City, but how far this extends northwest and southeast in this area I am unable to say from positive information. Some have appeared in the extreme southeast of Dakota, but from all I can learn this Territory is not likely to have any considerable portion of its area infested.

During Mr. Thomas's visit to Nebraska the severe cold storm of the latter part of April occurred, and he was enabled to note carefully its effect upon the eggs and young which were then hatching out quite numerously.

His second visit was in June, at which time the insects had advanced in some sections of his district to the pupa state, and at what may be designated as the critical period so far as this section was concerned.

The result of Mr. Thomas's visit to Nebraska at this time will be best shown by the following report made by him and Professor Aughey to the executive of that State, Governor Garber, to whom we are likewise greatly indebted for aid and encouragement in our work in Nebraska. We quote from the Omaha *Republican* of June 16, 1877, in which the report was first published:

In response to the request of Governor Garber and a number of citizens of Nebraska, Professors Thomas and Aughey have prepared a statement giving the results of their personal examinations of those portions of Nebraska in which the grasshoppers deposited their eggs last fall. The statement embraces information covering every such locality; and in their letter to Governor Garber, transmitting their report, Professors Thomas and Aughey state as their general conclusion that "although the locusts remain in limited areas in the eastern counties, the prospects in Nebraska are even more flattering than the most hopeful of your citizens anticipated a month ago."

THE REPORT.

Our examinations cover the greater part of the settled portion of the State, and have been made over quite an extensive area in person. From the other sections, which we have not been able to visit, we have obtained, within the last few days, direct and positive information which we are satisfied is correct. We have made it a point to visit in person the areas supposed to be the worst infested, and have not contented ourselves with inquiries at these points, but have gone out on the farms in order to see for ourselves the actual condition of affairs in this respect. Before mentioning any of the details we may state, as

THE GENERAL RESULT OF OUR EXAMINATIONS,

First. That the eggs have been nearly or quite all hatched out; at least, so few remain unhatched that it is wholly unnecessary to consider them in this report.

Secondly. That the locusts which hatched out in the sections west of the meridian of Lincoln have died off to such an extent that but few remain, not enough at any point, so far as we have observed or could ascertain, to do any injury to the crops.

Thirdly. The only section in which we find them in numbers sufficient to give any uneasiness is the eastern tier of counties lying along or near the Missouri River; and although found somewhat numerously in certain areas in this section, their numbers are much less than the most hopeful of your citizens anticipated a few weeks ago. Even these have done but little injury to crops up to the present time, and seem to have lost their usual ravenous appetites and vitality. In fact, scarcely an injured field can be observed in a day's ride through the sections where they are considered most numerous. We have traveled through these areas with persons from States east of the Mississippi, visiting Nebraska with a view of locating here or examining the lands, and without exception they have expressed surprise at the uninjured condition of the crops after the alarming reports they have heard.

Fourthly. In those sections where they yet remain, not only are they far less active than usual, but as a rule they are confined to very small areas irregularly distributed; or, as generally and correctly expressed by the farmers, "they are in spots." In such places the farmers are generally fighting them vigorously and with every prospect of success, and we are glad to say that they are, with few exceptions, hopeful and confident that they will suffer but little loss. As a general rule, we find the farmers confident that in the future they will be fully able to cope with the young. In some places precautionary and defensive measures have been neglected until the locusts have advanced to a size at which it is more difficult to destroy them. A few of the early hatching, where any of them remain, are already entering the winged state.

In looking over the State, therefore, as a whole, we feel fully warranted in saying that, so far as the young locusts hatched out this season are concerned, the danger has passed, and the citizens need not remain in uncertainty any longer. We are satisfied that the loss from their depredations, as compared with the whole crop, will be so small that its effect upon the State will not be felt. This opinion we believe will be fully borne out by the summary of facts hereafter stated.

* * * * * * *

THE PRESENT DISTRIBUTION.

Although the locusts hatched out quite numerously in various localities, as far west as the west line of the egg-deposit, they have almost entirely disappeared from all parts west of the meridian of Lincoln; and even east of that there are large areas in which there are none to be found, or at least so few that the farmers apprehend no danger whatever from them. Even in the sections where they are considered the most numerous, up to the present they have been limited to isolated spots. An examination made at one of the worst infested spots showed that the number of acres over which they then spread as compared with the number of acres in cultivation was so limited that it was evident that, with a reasonable effort, their destruction might be rendered certain. It is true that enough might hatch out on five acres to overrun and destroy the crops on one hundred and sixty acres if the season should favor them, and no effort be made to destroy them; but, at the same time, it is equally true that if all on the five acres are destroyed before they spread, the rest of the one hundred and sixty acres, at least, will be saved.

MIGRATING SWARMS FROM THE SOUTH.

That a few swarms from the south have recently passed over the western part of the State, going north, is undoubtedly true. So far but few, if any, have come down in the settled districts, and have done no injury whatever. Heretofore the swarms moving from the south northward toward their native habitat have not, so far as we are aware, done any injury in this State. We do not apprehend any damage from them; in fact, this is precisely what the commission anticipated and predicted, and is one of the strongest possible corroborations of the theory that they can never become permanent residents of this part of the Mississippi Valley. And we may as well reaffirm in this connection our oft-repeated conviction, from what we know of the history and habits of this species, that it is impossible for it ever to become a permanent resident of these border States, and hence that the race must run out here, and that it can only be continued by repeated invasions from its native habitat in the far northwest or Rocky Mountain region. This disposition to return also confirms our repeated assertions that it can never progress eastward as did the potato-beetle; that its line of eastern progress is as firmly fixed by climatic and physical causes as though its way were barred by some insurmountable barrier. We therefore maintain that the people of these States ought to confide in these conclusions of science which have been so signally borne out by the facts.

* * * * * * *

CONCLUSION.

In concluding this brief and hasty report, we have only to repeat what we have already said—that we consider the danger from the young which have hatched out this season in Nebraska over, and that this part of the problem is solved. *We also believe that the long series of visitations has come to a close.* There may be, and doubtless will be, at irregular periods, visitations by migrating swarms, but it is not at all likely that the present generation will witness another such a series as that which has just passed. We append hereto, as a part of this report, a brief account of the means of destroying the young and unfledged locusts which we have just issued in the form of a special bulletin for Nebraska.

Very respectfully,

CYRUS THOMAS.
SAMUEL AUGHEY.

At this time a special "bulletin for Nebraska," giving a condensed account how to deal with the insect, was issued and distributed not only in that State, but also in Northern Iowa.

From May 26th to the 28th the Commission met at Saint Louis for the transaction of business and the perfecting of plans for the future.

During the month of June Mr. Riley was most of the time in the field in the southern part of Iowa, touching also points in Nebraska and Kansas meanwhile. He would here acknowledge his obligations to the executive of the State, and to the professors at the agricultural college at Ames, for aid and encouragement.

The following letter will prove a record of the situation in this State up to the time it was written, while later occurrences are given elsewhere (Chapter 1, App. 6):

ATCHISON, KANS., *June* 20, 1877.

SIR: In accordance with your request and my promise, I herewith transmit a brief summary of my examinations, during the past fortnight, in reference to locust injury in the western part of Iowa, south of the Chicago and Northwestern Railway.

The rains, during most of the time, have been so severe and heavy as to render travel across the country often unpleasant and difficult; yet I have managed to examine the condition of things at many points along the Chicago and Northwestern from Council Bluffs to the eastern limit of the locust region in Story County; thence across to the Chicago and Rock Island; thence along the Chicago, Burlington and Quincy, and across the country from Malvern in Mills County, southwardly. Stopping at these points and pushing out to those farms where the insects were reported most numerous, and having reports from many points not visited, my conclusions are drawn with assurance, and, though favorable, are, if anything, not sufficiently so.

PURPOSE OF THE VISIT.

My examinations were partly in furtherance of the plan of the Commission to visit personally and collect the varied experiences of every State and Territory within the locust range; partly to ascertain the real prospects, and to encourage the farmers and disseminate information among them, where such work was necessary.

NO MORE EGGS TO HATCH.

A few straggling eggs were hatched as late as a week ago; but none now remain to hatch except a few from indigenous species.

DISAPPEARANCE OF THE YOUNG.

As elsewhere over the threatened region, the eggs were exceedingly numerous, and the young locusts hatched in April in such numbers, and began their work of destruction with such vigor, that the greatest apprehension was felt. They soon began to disappear, however, and this disappearance was due to the same causes enumerated some five weeks ago in my letter to Governor Anthony, of Kansas, reviewing the condition and prospects at that time in that State. Summarized, they may be stated as follows:

The weather.—The continued cold and heavy rains after the principal hatching destroyed immense numbers. I have known them washed into the Des Moines River so as to form a putrefying scum two inches thick. The farmer owes the salvation of his crops largely to this cause.

Climate.—An inherent tendency to disease in the species when in this part of the country has made it most susceptible to the adverse weather, and carried off a large proportion. This is an exemplification of the views constantly urged by me.

Natural enemies.—It is a general law that in proportion as a species becomes unduly and excessively multiplied its natural enemies correspondingly increase. The abund-

ance of the locust and of its eggs during the last few years east of the Rocky Mountains has given all locust-feeding animals a bountiful supply of food. They have, therefore, not only thriven and multiplied, but many which do not normally feed upon the insect have acquired the habit. In Iowa, as elsewhere, these natural enemies—especially insectivorous birds—have done exceptionally good work; a work furthered by the weather, which retarded and rendered very irregular the development of the insect.

The farmers.—Who have been better organized and more determined to make war, and who have used better means and methods than in former years.

GENERAL SURVEY OF THE FIELD.

As you are probably aware, the locusts reached the farthest east along the line of the Chicago and Northwestern, and the egg-deposit receded from Story County southwestwardly. Throughout the northern and eastern portion of this area the damage has been so trifling that it is scarcely worth mentioning. The corn, from too much cold and wet, is backward, and the weeds have on all low land got an unfavorable start of the cultivator; much of it also rotted and necessitated replanting; but the spring wheat (Fall wheat is too apt to spring-kill and is uncertain) and other small grain could not well look better. The greatest injury has been south and west, along the Missouri and along the Wahabouncey. As a general thing, the injury has been greatest along streams, where the insects hatched later and obtained greater protection from cold or storm. In these less-favored parts, however, there is no single farm that presents the desolate aspect so general two years ago. In restricted spots the insects are quite thick, and have done slight injury, but in a general way the prospects were seldom brighter.

WHAT WILL HAPPEN.

The insects have been getting wings in increasing numbers during the past week. These will rise from day to day, as the wind and weather permit, and fly away to the north and northwest. This, on account of the irregular hatching and the great diversity of size in the insects now here, will continue for the next two or three weeks, and the flights will consequently be so scattering as scarcely to be noticed. In the northeastern counties visited the farmers are out of danger. The insects are not more numerous than indigenous species sometimes are in dry seasons east of the Mississippi, and the vegetation is so rank that they can make no appreciable effect upon it. In the southwest counties there will be greater injury, and you may expect to hear of a cornfield cleaned out here, and a wheat-field more or less damaged there, where no precaution is taken against such an occurrence. Yet here, also, the average loss will be slight—no greater than it has been in Texas and South Kansas, where generally excellent crops have been or are being harvested. In fact, very much the same conditions prevail in the counties bordering on the Missouri east as in those in Nebraska west—where Professors Thomas and Aughey, on behalf of the Commission, have been making extended observations, and conclude that the loss from locust depredations will be so slight that its effect upon the State will scarcely be felt.

LESS FAVORABLE IN NORTHWESTERN IOWA.

Judging from numerous reports which reach me, the outlook is less favorable in the northwest counties. Indeed, from Humboldt and Kossuth Counties westward, the counties are far more gloomy. Professor Thomas has charge of that part of the State, and is now there. Much can be done to allay unnecessary alarm, and you may expect to hear from him.

SUGGESTIVE NOTES.

In passing through the magnificently fertile southwestern counties of your State, two things were particularly noticeable:

First. The want of divereity in culture. Corn is too supremely king. Some townships are one vast corn-field; and while the farmer generally instinctively plants that which pays him the best, he often does so from habit and imitation. In a country

subject to locust ravages disaster is averted by greater diversity. Without discussing the advantage of a diversity of crops, the advisability of growing more stock must be obvious: first, to consume the corn at home; secondly, to avoid sweeping disaster. Had the season been less unfavorable to the locusts, they might have cleaned out the grain-fields, and, as is their wont, left untouched the wild prairie meadows. *Verbum sat sapienti.*

Secondly. In every community there are those who persist in doing nothing to prevent locust injury. These individuals frequently bring ruin not only upon themselves, but upon more persevering neighbors. There is need of more organization, and Iowa needs some such law as her sister States north and west passed last winter—a law that will oblige every able-bodied man to work one or more days, either in the Fall in destroying the eggs, or in the spring in destroying the young insects, whenever the township trustees, at the request of a given number of citizens of the township, may call them to such work under special provisions similar to those of existing road-laws.

[Here followed some practical suggestions that are given in Chapter 13.]

Sundry devices for the use of both coal-oil and coal-tar have been patented, and the patentees in some instances charge an exorbitant and unreasonable royalty. I would advise farmers to

SAVE THEIR MONEY.

The principle of destruction cannot be patented, since coal-oil and coal-tar for the destruction of locusts have been used in former years, and extensively in Colorado. Their use against insects is a public privilege and possession.

The particular construction of the machine is immaterial. Farmers will thank manufacturers who sell at a decent profit, but should give no encouragement to those who charge thrice what a machine is worth because of a patent.

PROSPECTIVE DAMAGE.

There is some apprehension from swarms from the south, and from fresh flights later in the season from the northwest. I think there is little danger of either. The return swarms in summer from the country south are never very disastrous. The insects have been flying north and northwest for about six weeks, but so scattered that, as I anticipated five weeks ago, no serious injury has followed their settling. They fly mostly west of Iowa, and when they do injury it is generally near the British-American line. That there will be no fresh visitation of a widespread character later in the year from the northwest there is every reason to hope. The native breeding-grounds must have been measurably depleted last year, and the return migration has been so far, and doubtless will be, slight. This reasoning applies to the section of your State which I have visited. It will apply to all the country south and east of the forty-fourth parallel and one hundredth meridian, but will hold less and less true as we go north and west of those limits. Altogether the outlook is favorable. From excessive wet, and for other reasons, the ordinary grain pests, like the chinch-bug, will be harmless, and with favorable weather henceforth there is very reason to feel encouraged.

I have the honor to remain, yours, respectfully,

C. V. RILEY.

His Excellency Gov. J. G. NEWBOLD,
Des Moines, Iowa.

Mr. Packard started west after the Saint Louis meeting, and reached Denver, Colo., on the first of June. He spent several days at Morrison and Greeley, collecting facts about the young and return migration from the southward. May 29 and 30, he made observations at Julesburg and vicinity; June 7–11, at Salt Lake, Farmington, &c.; June 12–24, he passed through Idaho into Montana, stopping at Virginia City, Bozeman, Helena, and Fort Benton. From here he passed down

the Missouri River June 24–27, and through Dakota to Saint Paul and home, reaching Salem July 5.

As the result of this journey, the Commission was able to confirm the belief it had previously announced, that there were no unfledged locusts in a very extensive region of the Northwest, comprising large portions of Montana, Dakota, and also British America, for about two hundred and fifty miles north of the Missouri River, a region bounded on the north by the Saskatchewan River. As this region, together with the Yellowstone Valley, is usually the great breeding-ground of the Rocky Mountain locust, the Commission felt more confidently enabled, from the state of things there and in Wyoming and Colorado, to predict that there would be no serious invasion of the border States from Texas to Minnesota in the summer and autumn, which would insure an immunity from the attacks of young locusts, at least in 1878. It was also ascertained that the tracts of country in Colorado, Utah, and Idaho, where eggs were laid the year previous, and unfledged locusts were observed in greater or less numbers, that the cold, heavy rains of April and May, and the parasites, had, as in the Mississippi border States, so materially reduced their number as to render them powerless to do material harm, except in Cache and Malade Valleys, in Northern Utah, while serious local damage was committed by them in Bitter Root Valley, Montana. Much information was also obtained during this trip regarding locust occurrences in the Territories and in British America. (App. 9.)

During the first week in July, Mr. Riley took the field in Colorado, and the following letter, written just before his return, together with data subsequently obtained (Chapter I, App. 7), will form a summary of the state of things:

To the editor of the Colorado Farmer:

DEAR SIR: Upon my arrival in Denver, three weeks ago, you requested me to furnish you with a brief account of my intended observations in Colorado before my departure. I can find time for but a few hurried jottings.

OBJECT OF VISIT.

As you are already aware, my visit has been in furtherance of the work of the United States Entomological Commission, and my investigations have had reference to the Rocky Mountain locust, or grasshopper. It gives me great pleasure to state that all whom I have met with in Colorado, from the State officers down to the humblest farmer, have generously assisted in my efforts, and expressed a hearty sympathy with the work of the Commission. After visiting Greeley, Golden, Boulder, and other points north of Denver, and some of the ranches lying along the Denver and Rio Grande Railroad, I found very little that was instructive beyond what intelligent correspondents had already communicated. Hence, I spent as much time as possible in the mountain passes and cañons, especially those within easy reach of the narrow-gauge road already mentioned, to the officers of which I am under special obligations for liberal aid. Mr. William Holly, of Del Norte, has, on behalf of the Commission, visited most of the interesting points which I have had no time to reach, in Park, Lake, Gunnison, Fremont, Saguache, San Juan, Rio Grande, Conejos, and Costilla Counties.

RETROSPECTIVE.

In all the States to the east invaded last year, the eggs of the locust were laid very thickly, and the gravest apprehensions as to injury existed as spring opened. Nor were these without warrant. Notwithstanding those eggs which were destroyed during the winter by enemies, and those which prematurely hatched in the fall and during the mild weather of February, enough hatched in April to cause consternation. Throughout the invaded country lying east of Colorado, already visited by the Commission—which includes all the States affected, from Texas to Minnesota—the insects have disappeared without, in a general way, doing any very serious injury. What with the increased number of birds and their other enemies, the more determined efforts made, and improved methods of warfare employed against them by farmers, the heavy, cold, and continued rains that followed the principal hatching, and the greater debility and tendency to disease among them everywhere noticeable, the young insects rapidly decreased in numbers, and those which survived to acquire wings rose and flew to the northwest in scattering swarms. Even in Northwest Iowa and a few counties toward the southwest of Minnesota, where the injury was greatest, the insects have not remained to deposit as they did in past years. They continued to die off, and finally left, or are now leaving, after doing more or less injury.

I have been much interested in finding how thoroughly the conditions above described have prevailed over all parts of Colorado having an altitude less than 7,000 feet above the sea-level. There were more eggs laid in Colorado last Fall than during any previous year that those whom I have conversed with remember. The principal hatching in April was followed by continued cold rains and snows, which would partially thaw during the day and freeze again at night, so that the young insects were alternately subjected to much slush and frost. In early summer there was by far the largest amount of rain-fall known for many years in the State. The insects were weak and died and disappeared. Birds were unusually serviceable in destroying them, and one little gray gregarious species, described to me as being abundant and efficient in February, and which is perhaps the horned shore-lark (*Erimophila alpestris*), I have not noticed to the east.

Very much the same condition of things occurred all over the State below the altitude stated, whether in the northern half or along the eastern base of the Sangre de Cristo and in the Cucharas Valley, where the insects hatched more thickly. Few years have been more favorable to the Colorado farmer. I have noticed a number of poor wheat-fields, resulting from defective irrigation or other causes, but the average yield will, I think, be from twenty to twenty-five bushels to the acre. A good deal of rye was so burnt out that it had to be prematurely cut and used for hay. Barley has yielded from twenty-five to thirty bushels per acre, and the yield of oats will be fair. Corn looks well, and stock of all kinds is in excellent condition. In Lake County, where there is an extensive area under cultivation along the Arkansas, and where the damage was great last year, few locusts hatched the present year. In Park County, mostly devoted to grazing, the injury has been slight The San Luis Valley, which is devoted to agriculture and stock-raising, has suffered little, and the beautiful Ute Valley has also, as is usually the case, been singularly free. In the Wett Mountain Valley, which is specially subject to injury, the farmers had to fight early in the season, and the injury in the valley of the Costilla, where fields were cleaned out by the young locusts, was greater than in any other part of the State, The severe injury extended southward into New Mexico, where the valley of the Taos has been swept clean; yet, on the opposite side of the mountains, the president of the New Mexico Stock and Agricultural Association reports to Mr. Holly no injury occurred, the young insects having disappeared.

CONDITIONS IN THE PARKS AND PASSES ABOVE THE ALTITUDE OF 7,000 FEET.

While in the lower plains and valley regions of the State the conditions have been so similar to those which prevailed toward the Mississippi, they have been quite dif-

ferent in the higher plateaus and parks. At altitudes of from 8,000 to 9,000 feet above the sea, the principal hatching occurred in May, and was later in proportion as we ascended, until, in the places with an altitude of 12,000 to 13,000 feet, the insects are still hatching. At such great heights the mature dead are often to be found in large quantities under stones and other shelter, which they sought last fall when prematurely overtaken by winter, and their young are hopping about in great numbers. As no agriculture is carried on in these parks and passes, no effort is made to destroy the insects.

THE LOCUST PROBLEM MORE COMPLICATED IN COLORADO THAN IN THE LOWER MISSISSIPPI VALLEY.

It is in consequence of the above facts that the locust question becomes so complicated in your State. Colorado combines within her limits the meteorological and climatic features of a dozen States. In the Mississippi Valley country, there are laws governing the Fall invasions from the northwest and the return migrations in summer on which to predicate with tolerable assurance. This is more particularly true south of the forty fourth parallel. Your most disastrous swarms also come from the north and northwest, and the insects which hatch out on your plains east of the mountains are largely governed by the same laws and instincts as those which hatch to the east; on acquiring wings they leave, and those that rise before the second week in July will bear mostly to the north and northwest. This is more particularly the case south of the divide. After the middle of July the rains increase and the winds are more variable, prevailing, so far as I have yet ascertained, greatly from the east or south in the morning, but stronger from west or northwest in the afternoon. Swarms are liable, therefore, at almost any time after the middle of July, to swoop down from the parks and plateaus west of the range upon the valleys and plains to the east. These remain within your borders, or, if they pass beyond, bear southeastwardly toward Texas. From what light the Commission so far possesses, it becomes more and more plain that I have been correct in considering the species as boreal,* and in locating the breeding-grounds of the more disastrous swarms, like that of last year, in the plains regions of the extreme Northwest, where the summers are short and the winters long and severe. I find the exodus of the winged insects from that portion of your State lying east of the mountains less complete than in Kansas and Missouri, for instance, and of the earlier matured individuals that have not left, some commenced ovipositing a week or so since. The young from eggs laid thus early will prematurely hatch this summer or Fall, and inevitably perish; just as those now hatching toward the snow-line will perish before attaining maturity. The insect is single-brooded, and the tendency to produce two broods where the summers are too long, is as fatal to the perpetuation of the species as the want of time to properly mature a single generation where the summers are too short. Both extremes obtain within the limits of your State, as, also, the intermediate conditions in which the species can thrive permanently; whereas in no part of the Mississippi Valley south of the forty-fourth parallel, and, probably, some degrees farther north, can the species hold its own continuously, and, with few exceptions, it seldom remains a single year.

PROSPECTIVE.

While the record in Colorado up to this time is so interesting, in comparison with that in other States, the probabilities during the rest of the season more deeply interest your people. "What are the prospects?" This is the question put to me on every hand. The farmer who is just about harvesting his wheat is anxious to know whether the chances are that it will be suddenly ruined by the winged pests, as it has been in past years, or that it will be unmolested.

* We have in former writings designated the species as subalpine, but the term here used in its zoölogical sense is more strictly correct, implying that region, as the Saskatchewan and Lake Superior areas, between the subarctic and north temperate.

From what I have said above, it follows that I cannot predicate with the same assurance that I have done in Texas, Missouri, Kansas, and Iowa; but, to be brief, the prospects are, in my opinion, quite favorable. * * *

Dr. Packard, of the Commission, who has been through Utah, Idaho, Montana, and Wyoming, confirms my conclusion that the Northwest must be measurably depleted, for he could not find a locust in Montana from the Idaho line up to Fort Benton or down the Missouri line to Bismarck. None are to be seen in the region south of South Saskatchewan, and there is an immense area free from them in their native home. There is very little danger, then, of injury from Fall swarms from the Northwest, unless they come from the Black Hills country. There remains the chance of swarms from your own western parks and plateaus or from those of Utah; but I have good reasons for believing that they will prove no more injurious than the swarms which have been passing on several days since I have been in the State from said western hatching-grounds. There is a constant struggle for supremacy between the plant-feeder and its carnivorous enemies. The Rocky Mountain locust got the upper hand during the excessively dry seasons of the early part of the present decade, and has been so numerous for the past three or four years that its enemies have rioted in plenty, and at last, in their turn, have increased inordinately. In all your parks the Tachina flies (which produce the parasitic maggots known to infest the locust) are so numerous as to cause a constant buzzing like a swarm of bees, and to prove a positive nuisance to tourists. Every winged locust that attempts to fly is pursued by three or four of them, and the locusts that are daily rising from said parks, whenever the breeze is favorable, are very generally parasitized and diseased in consequence. The same holds true, as I learn from reports, in Utah, and as the parasites will increase as the season advances there is no reason to believe that the later swarms from the west of you will prove more injurious than those that have already left. The same will also largely hold true of those which leave the Black Hills country, though I have less positive information from that region. Nature maintains her average in the long run, and a few seasons of drought and locust ravages are apt to be followed by a period of more rainy seasons and locust decrease.

REMEDIES.

As these have been quite fully given in the Commission's bulletins, and are not particularly called for at this season, I will dismiss the subject with the remark that I have found no means employed in Colorado that are not employed in other States, except as your irrigating ditches permit of a peculiar and satisfactory use of coal-oil. I should, perhaps, except also one means employed in the Wet Mountain Valley, where, as the young insects pass from the ledges and benches where they hatch into the valley, they are so effectually rolled into a slush made by overflowing the ground, that a pestilence from their dead bodies is sometimes threatened. I think your farmers are not sufficiently appreciative of the dry ditch, which could often be used to great advantage where other means fail.

* * * * * * *

The Commissioners consider it their duty not only to disseminate information already possessed, but to gather from all parts of the country the facts peculiar to each section, for experience differs immensely with latitude and surroundings. The flights of the winged insects—their direction and the direction and force of the wind at the time in Colorado during the rest of the season—will be of great interest, and the Commission will feel under obligations to any of your readers who will send me notes thereon.

Yours, very truly,

C. V. RILEY.

SUMMIT, LA VETA PASS, *July* 28, 1877.

Mr. William Holly, of Del Norte, as stated in the above letter, was employed as special assistant in this State, traveling extensively on horseback during June and July to collect information in the southern counties. His report, with other data, appears elsewhere. (App. 7.)

Prof. O. S. Westcott, of Chicago, also made a trip for us to this State during the month of August, while Prof. R. L. Packard, of the Patent Office, visited the State earlier, in order to make some chemical experiments.

The Commissioners met and held a third meeting in Chicago, Ill., August 7–8, for consultation and the transaction of necessary business. After planning for field-work for August and September they separated, to meet again on the 1st of October. Mr. Packard started west, reaching Salt Lake August 12; thence he went through Nevada, obtaining new facts about fresh invasions of locusts from Idaho, stopping at Reno, and thence, by way of Lake Tahoe, where the species of locust destructive in California was observed, he went to Portland, Oreg., tracing in the Shasta Valley and about Portland the small form allied to the Rocky Mountain locust. Going up the Columbia River to The Dalles and to Wallula, information was obtained regarding the western limits of the Rocky Mountain locust and recent invasions in Eastern Oregon and Washington Territories of this locust.

Returning to San Francisco by way of Victoria, Vancouver's Island, where collections were made of locusts allied closely to the Rocky Mountain species, considerable information was received at Merced, Stockton, and places along the road to the Yosemite Valley, regarding the ravages of the *Caloptenus atlanis*, the destructive locust of California, and, from observations made in the mountains, as well as on Mount Shasta, at the northern extremity of the Sierra Nevada, it was definitely ascertained that swarms of the Rocky Mountain locust have probably never flown over that range from the plains east, and that the damages done locally on the Pacific coast have been most probably committed by *Caloptenus femur-rubrum* and *C. atlanis*, conjointly or separately, both of these species conjointly causing similar losses in the Atlantic States. Mr. Packard returned to Salem on October 4.

The results of this journey may be summed up as follows: Definite information was obtained concerning the invasion of Northern Nevada and Eastern Oregon and Washington Territory by swarms of the genuine Rocky Mountain locust, and all of the swarms were traced with a good degree of accuracy to the Snake River Valley, in the vicinity of Boise City and northward and southeastwardly. The western limits of the Rocky Mountain locust were definitely ascertained to be near the meridian of 120°, extending along the limits of this line from latitude 58° to 37°. It is most probable that while this locust may occasionally, in Washington Territory and Oregon, fly to the eastern flank of the Cascade Range, and in California as far as the eastern flank of the Sierra Nevada, swarms never pass over those mountains. (For detailed notes of this journey, see App. 10.)

During the last days of August and first of September Mr. Thomas again visited the Northwest in order to consult with his assistants, bring together the data obtained, and arrange it in reference to the report. The meeting was held at Sioux City, Iowa, after which Mr. Thomas, ac-

companied by Mr. Whitman, visited various parts of Northern Iowa in order to gather specimens of those which had dropped from flying swarms, and to ascertain exactly the eastern limit of their extension in this latitude.

In addition to these visits, Mr. Whitman traveled extensively over the counties ravaged by the locusts in Minnesota, and Professor Aughey over those of Nebraska.

Mr. Riley started, after the Chicago meeting, for Manitoba, remaining a few days on the way in Minnesota to ascertain the extreme eastern limit of flight in Hennepin and Ramsey Counties. Most of the month of August and part of September were spent in Manitoba, where he was fortunate in meeting the Hon. M. P. Mills, minister of the interior, and the Hon. Mr. C. A. P. Pelletier, minister of agriculture, of Canada, both of whom are strongly in sympathy with the work of the Commission. Indeed, Mr. Pelletier had our first circular reprinted and sent out by the Dominion council. While at Winnepeg he was under many obligations to Bishop Taché, Governor A. Morris, many Hudson Bay factors, and other officers, but especially to Mr. J. W. Taylor, United States consul, whose uniform kindness and whose extensive knowledge of the Saskatchewan country materially helped to make his stay pleasant and profitable. This trip gave us much definite information regarding the destination of the early summer flights, and regarding the northern and eastern limits of the species' spread and of its permanent breeding-grounds north of our boundary-line. These permanent breeding-grounds turn out to be much more clearly defined than we had reason to hope, and they are, in a broad way, coequal with the limit of what is known as the third prairie plateau or steppe, an immense plains region drained by the South Saskatchewan and the Red Deer River. We were also able to obtain evidence of great locust abundance in this country as far back as the very beginning of the present century. (See Chapter 1.)

A fourth meeting of the Commission was held in Chicago, October 1–2, for the further transaction of business and to complete the division of labor on the report. During this month Mr. Riley made a trip to Kansas, as far as Manhattan, with a view of ascertaining whether any of the insects that had hatched in the spring had remained in that section of the country (App. 14); while in November he made a brief trip as far as Dallas, Tex., for the same purpose and to get facts as to autumn flights.

The fifth meeting of the Commission was a protracted one, held in Washington during the latter part of January and early part of February, 1878, for the purpose of comparing and digesting the work done on the report and preparing the same for the printer. By comparing and interchanging notes the report has been made as much as possible a whole, and opinions expressed or conclusions drawn are those of the entire Commission, unless dissent therefrom by any one member be expressed in a note. The chapters have been severally prepared as follows:

Introduction. By Mr. Riley.

Chapter 1. Classification and Nomenclature: Characters of the Species. By Mr. Thomas.

Chapter 2. Chronological History. By Mr. Packard.

Chapter 3. Statistics of Losses. By Mr. Thomas.

Chapter 4. Agricultural Bearings of the Subject. By Mr. Thomas.

Chapter 5. Native or Permanent Breeding-Grounds. By Mr. Packard.

Chapter 6. Geographical Distribution. By Messrs. Thomas and Packard.

Chapter 7. Migrations. By Messrs. Packard and Thomas.

Chapter 8. Habits and Natural History. By Mr. Riley.

Chapter 9. Anatomy and Embryology. By Mr. Packard.

Chapter 10. Metamorphoses. By Mr. Riley.

Chapter 11. Invertebrate Enemies (Insects, &c). By Mr. Riley.

Chapter 12. Vertebrate Enemies (Birds, &c). By Mr. Thomas.

Chapter 13. Remedies and Devices for Destruction. By Mr. Riley.

Chapter 14. Influence of Prairie Fires on Locust Increase. By Mr. Riley.

Chapter 15. Influence of Weather on the Species. By Mr. Riley.

Chapter 16. Effects that generally follow severe Locust Injury. By Mr. Riley.

Chapter 17. Uses to which Locusts may be put. By Mr. Packard.

Chapter 18. Ravages of other Locusts in the United States. By Mr. Riley.

Chapter 19. Locust Ravages in other Countries. By Mr. Packard.

The first chapter relates to the classificatory position, name, and characters of the species, which, while belonging to the same family as the locusts of the Old World, is nevertheless purely an American insect, occurring on no other continent. For a correct and proper understanding of the whole subject, it is very essential that we discriminate between certain closely allied species, which are easily confounded by the non-entomologist, and which yet have very different habits and instincts, By means of a large amount of material from all parts of the country, and by study of the immature stages, we have been able to accurately define the three forms most apt to be confounded, and they will be distinguished throughout the report by the popular names of Rocky Mountain locust (*Caloptenus spretus*), Lesser locust (*C. atlanis**), and the Red-legged locust † (*C. femur-rubrum*). We consider them good species, as species go, and the plates will at once show their distinguishing characteristics. As is found to be the case with nearly all species when large material from widely different sections is studied, there are several varieties and races that may be grouped around each of these three typical forms, and which are intermediate between them; but it has

* Originally defined from specimens from the New England States, but subsequently found to have a very wide range and not to be confined to the east.

† Long known by this popular name on account of the red shanks (tibiæ) which are not, however, confined to this species but are characteristic of all three under consideration.

not been deemed necessary to confuse the ordinary reader by further definitions in this chapter, since it is the intention to give in a separate memoir a synopsis of the genus, with descriptions of all the North American species at present known.

In the second chapter we have given a chronological record of locust injury in this country, which shows it to be no modern occurrence; and if the injury appears to have increased of late years it is only because there is a larger cultivated area within the locust region, and the devastation is more noticeable. The impression that this insect is on the increase, and that its invasions are becoming more general and more frequent is wide-spread, but it is scarcely justified by the facts, which clearly indicate that the species has for centuries (and doubtless for centuries of centuries) been at times excessively abundant and injurious to the vegetation of the western plains. The history of 1877 is given rather fully in this chapter, and is interesting in that it differs from that of 1875, the year when the insects also hatched out in so large a part of the temporary region. In that year the hatching was more uniform, the young more vigorous, and, notwithstanding the spring and early summer were as wet and stormy as in 1877, the destruction of crops was complete. In 1877, though the eggs were more numerous, the hatching was more irregular, the young insects more feeble and diseased, and the destruction, except in a few counties of Northwestern Iowa and Minnesota, was trifling. The reasons for the difference in the two years are sufficiently obvious. The winter of 1874–'75 was severe and steady—more in keeping with the boreal country where the insect is at home—and the eggs were well preserved and hatched more uniformly; moreover, they were laid by insects fresh from their northwest home. The eggs laid in 1876 were largely from insects from the subpermanent country; they were subjected to much mild and changeable winter weather, while the spring rains were cold and disastrous to the young. In addition to these facts, the increase of natural enemies that inevitably followed the few years of locust abundance, and the greater efforts of the farmer, and better means of fighting, should be taken into account.

Chapter 3, in showing that the loss to the States between the Mississippi and the Rocky Mountains from this insect between 1873–'77 amounted to about $200,000,000, will serve to convey an idea to those not conversant with the facts of the vast importance of the question and the prominent rôle this tiny locust plays in the destiny of the country. When we reflect that these losses fell most heavily upon a frontier population without wealth, we cease to wonder at the suffering and consternation that at times prevailed, and must admire the courage and fortitude with which the people have fought adversity. A means of arriving at these losses from two wholly different stand-points, and from entirely different data, has been employed, thereby rendering the one a check upon the other.

Chapter 4 treats of the effect of locust injury upon the agricultural

progress and development of the West; the crops most liable to and those most exempt from injury. It also discusses the best modes of cropping and the mode of farming that will give greatest security against locust ravages.

The facts brought forward in considering the native or permanent breeding-grounds (Chapter 5) show this locust to be essentially boreal, and that, in its normal condition, it is confined to the more northern plains. The area of its permanent abode lies principally east of the mountains, between latitude 37° and 52° and reaching to about the 102d meridian. West of the range the permanent breeding-grounds seem to be confined to more limited areas in the Snake River Valley and Cache and Malade Valley regions.

The chapter (6) on geographical distribution gives the limit of the range or spread of the species. The data obtained during the year fix the eastern limit along almost precisely the same line at which it had been previously established, broadly along the 94th meridian; but the northern, western, and southern boundaries are for the first time established with anything like definiteness. The exact eastern limit is given in the chapter. It is an interesting fact that both north and east the limit is, in the main, coequal with the timber line. West of the mountains the line is in the neighborhood of the 118th meridian, the Cascade and Blue Mountain Ranges and the moisture beyond them appearing to be the most obvious barriers.

The Commission has made an especial effort to record all the movements of locusts during the year 1877, no less than 2,500 observations being recorded. The managers of each of the three lines across the country, viz, the Atchison, Topeka and Santa Fé, the Kansas Pacific, and the Union Pacific, assisted us by republishing our queries and instructing their agents to report, so that we had three almost parallel lines checking each other.

The data in the chapter (7) on migrations and in the appendix (App. 12) show very clearly that the movements of the winged insects that hatch out in the temporary region is toward the north or the northwest early in summer, the direction being more and more due north toward the eastern limit. In other words, there is, as we first declared three years ago, a return migration toward the native breeding-grounds of the insects hatching in the temporary region. This return movement is very constant east of the plains and south of the 44th parallel, but less so north and west of those lines. Thus in Minnesota, from which the reports are very complete, the movements are much more irregular than in Iowa, and they are most regular in Texas. It is well established that there may be two contrary currents over considerable areas, while good evidence is produced to show that flight is not unfrequently continued into the night, especially during fair, warm, and dry midsummer weather.

The observations in the extreme Northwest are meager, and while

flights from the south are recorded in July, passing over the Cypress Hills region in Northwest Territory, and reaching the North Saskatchewan at a few points, and even passing some distance north of Fort Carleton, yet from the want of data in the intermediate country we cannot say positively that these were continuations from our side the boundary-line, though the probability is that they were. The evidence —and it is very complete—indicates that some of the swarms that went northward the past season, through Minnesota and Dakota east of the Missouri, penetrated north of the boundary-line; but we know from the history of 1875, and from the experience of the Hon. Donald Gunn, of Winnepeg (App., 11), that the return migration does at times reach beyond said line, and that the insects often pass from the south over Manitoba during the month of June, or so early as to imply development several degrees south of that province.

The question as to what eventually became of these northward-returning swarms was everywhere asked during the summer. The evidence is clear that, as in previous years, these returning insects were mostly so diseased and parasitized that they dropped in scattered numbers and perished on their northward and northwestward journey. This is no theory, but known to have been the case in the more thickly settled parts of Kansas, Nebraska, Iowa, and Minnesota, from which the insects that dropped were reported, and in some cases sent to us. Mr. J. G. Kittson, of Fort Walsh, Cypress Hills, British America, also reports that those which alighted there gradually disappeared without taking further flight, and that they were badly attacked by parasites (App. 11). As this return flight is principally over a vast plain and prairie region that is thinly settled, the number of insects that dropped and were lost to sight in said plains must have been infinitely greater than that which was observed to come down in the more thickly settled regions to the east. We found the insects sparsely spread over the rank prairies west of Brainerd, along the Northern Pacific, and along Red River, and by this we mean that a few would hop from the grass at every step wherever we searched for them. We met with only here and there a straggler in Manitoba; but they were more numerous, as we have just seen, farther west. After the middle of July the flights began to trend in the opposite direction, or toward the south, and the data, which we have been at some pains to obtain on the autumn flights (App. 12), show that they were, as usual, pretty constant in the same direction. It is clearly shown that in the more northern parts of the country the northward-bound insects are often driven back and forth, constantly diminishing in numbers, and from their harmlessness and the fact that the northwest breeding-grounds are known to have been measurably free in spring, it is more than probable that the autumn flights over the temporary region were made up of the more robust of the insects that had, earlier in the season, left that region. West of the Rocky Mountains, and in restricted sections in Montana, east of them, the flights prevail in other directions.

Chapter 8 will be found to contain all that is at present accurately known on the general habits and natural history of the species, bringing out a number of new facts and correcting some errors which have heretofore prevailed. We would call especial attention to the portions which treat of the locations where eggs are preferably laid, the conditions of soil which most assist hatching, the general habits of the young, and to the two subchapters, which show that in the temporary region, south of the 44th parallel, the return migration to the Northwest is so complete that no insects of any consequence remain in the autumn, and in which are given the reasons why, in said region, the eggs are never laid thickly for two consecutive years, and, as a consequence, severe injury in spring and early summer for two such consecutive years never takes place. We have also discussed here the philosophy of the migrating habit, showing pretty conclusively that it is not to be attributed to one cause alone, but to several causes.

The chapter on embryology and anatomy contains observations on the mode of growth and hatching of the embryo, and gives new facts regarding the external structure of the locust and the internal anatomy of the respiratory organs concerned in lightening the body during flight. The general and minute anatomy of the digestive system and of the nervous system is also for the first time given.

The chapter on transformations will be found interesting as giving exact knowledge on the number of molts suffered by the species, mode and manner of molting, and of getting wings, and the structural changes that take place during growth.

In chapter 11 will be found an illustrated account of all the more minute enemies of the locust that are known to attack it in this country. Several interesting scientific discoveries are recorded, and among these we would draw especial attention to the interesting transformations of the locust-mite, which is parasitic in its early 6 legged state upon the mature insect, and in its adult 8-legged state destroys the locust-eggs; also to the curious life-history of the blister-beetles, which in their larval state turn out to be locust-egg destroyers. The excessive multiplication of most of these natural enemies was very generally noticed during the past year, the ground in some places being red with the egg-feeding mites, and the air full of swarms of the Tachina-flies, from which come the maggots that eat out the vitals of the locust.

In chapter 12 are given the locust-feeding habits of many western animals not heretofore known to have that habit; and the good offices of birds are specially made manifest, examinations of the stomachs of over 90 species and 630 specimens having been made with special reference to their locust-eating habits. The record in reference to these examinations is very full, giving the date, the locality, the common and scientific names of the species, and the number of locusts and of other insects found in each. The value heretofore placed on these aids by entomologists is fully sustained by this record.

In chapter 13, which is one of the most extended and most important practically, it is clearly shown that the young locusts may be controlled, and by what means, while the way is pointed out how to better control the winged insects. Many valuable devices for destruction are illustrated, among them one invented by Mr. Riley, which gave entire satisfaction, and will, it is believed, supersede other contrivances as a cheap and practicable means of destruction, applicable at any season, whether the plants or the insects be small or large. In this chapter, also, the necessity of legislation, the relative merits of ditching, plowing, harrowing, the use of coal-oil, of various fluids and powders, and of burning are discussed; as also the best means of protecting special plants and trees.

In chapters 14 and 15 the influence of prairie-fires and of weather on locust-increase is discussed. It is shown that prairie-fires can have but little influence on the multiplication of the insect except when they are judiciously manipulated and controlled as suggested in chapter 13. The effects of frost and of wet weather on the eggs and on the young insects have an important practical bearing, and we have given a series of experiments which prove that the eggs are not greatly influenced either by frost or water. That they should resist intense cold was to be expected, since the species is boreal; but that they should remain impervious to constant soaking, is contrary to the prevailing views hitherto held on the subject. They are, also, far less susceptible to alternate freezing and thawing than was anticipated. The young locusts, on the contrary, perish whenever the temperature falls more than fifteen degrees below freezing-point, while they are very seriously and injuriously affected by prolonged wet weather, especially if it be cold in addition.

The effects that invariably follow severe locust-injury are treated of in chapter 16, and the changes that, in consequence of such injury, take place in the flora and fauna—the increase of some species and decrease of others—are sometimes very striking. It must also be assuring to the people of the West to know that there are good and sufficient reasons why a year of great locust-devastation is apt to be followed by one of locust-immunity and good crops.

In chapter 17 we have discussed the uses to which locusts may be put, and, not to dilate here on their availability as food for various animals, including man, as fish-bait, or as manure, the chemical analysis given of the dead locusts is quite interesting. The insects furnish a new oil, which we have christened Caloptine, and a very large percentage of formic acid. Though this acid exists in the ant and some other insects, it is with difficulty obtained in large quantities; whereas by the action of sulphuric acid upon the locust-juices it passes off with great readiness and in remarkable quantity and gravity. The various uses of this acid, whether as a therapeutic, &c., are capable of great and valuable extension where it can be obtained so readily and in such quantity.

In the two concluding chapters it is clearly shown that locust-ravages

are by no means confined to the country west of the Mississippi, but may occur and have occurred in other parts of the country, at times in great intensity. It is also shown that no quarter of the globe is exempt from these pests, and that the countries bordering mountain-ranges in Southern Europe, Asia, and Africa, especially, have, since biblical times, and, doubtless, ages before, been devastated at irregular periods by devouring locust hordes.

We cannot well close this introduction without some statement of our views as to the locust-prospects for the immediate future, since our opinions are constantly being asked for. That the insect will, in the future, again pour down at times from its breeding-grounds into the temporary region, unless, by the co-operation of the two governments interested, it is prevented from so doing by the course we recommend, or by some still more feasible course yet to be discovered, there can be no reasonable doubt. Yet, in proportion as that country becomes settled will locust-injury be more and more easily controlled. But we do not hesitate to give it as our deliberate opinion that there will be no serious injury in such temporary region the coming summer, and, probably, not for several years to come. We rest this conclusion, first, on our personal examinations the past autumn over much of the country named; secondly, on the reports of correspondents in said country (App. 14); thirdly, on the reports from the extreme Northwest, or permanent region. These show that none of the insects of any consequence that hatched in the temporary region remained to lay eggs; that scarcely any eggs were laid by the scattering autumn swarms, and that, with few exceptions, the permanent region east of the mountains is likewise remarkably free of eggs.

CHAPTER I.

CLASSIFICATION AND NOMENCLATURE—CHARACTERS OF THE SPECIES.

The great damage done in the West during the past few years by "grasshoppers" has caused these insects to be more closely observed than formerly, and the members of the Commission are from time to time receiving specimens from persons both east and west inquiring whether they are the much-dreaded species. We have therefore concluded to give a brief outline of the classification of the family to which this species belongs, and of the characters by which the group and species may be distinguished from other groups and species which are closely allied.

When the popular name of a group of insects or other animals, that is generally accepted, corresponds somewhat closely in its application to the scientific division, it is not difficult to convey to the general reader a correct idea of the position and characters of a given species by reference to and comparison with well-known species of that group. Unfortunately, in the present instance, not only is the opportunity for reference to well-known species wanting, but the popular names applied to species and groups are so confused and erroneous that their use is calculated to convey incorrect ideas to unscientific readers.

Even the name *locust* as formerly, and yet very generally, applied in this country is incorrectly used, referring to an insect not even belonging to the same order as the locusts of oriental countries.

The "seventeen-year locust" of North America is, in fact, not a locust in the true sense, but a species of *Cicada*, or harvest-fly, belonging to the order *Hemiptera*, which contains only insects with a mouth prolonged into a horny, jointed tube formed for sucking the juices of the plants or animals on which they feed.

On the contrary, the locusts of the Old World, to which the term was originally and correctly applied, are species of migratory grasshoppers belonging to the order *Orthoptera*, and are furnished with strong biting jaws or mandibles. There are other very material differences between the two, but these will suffice to show that they are quite distinct.

The very common name "grasshopper" has likewise been unfortunate in its use and application not only in a popular sense, but even by scientists, referring at one time to the true locusts or to the various species of the family to which they belong, and at another to species of a different family, which includes katydids. In fact, the term as generally used applies to most of the species of two different families of *Orthoptera*. In order, therefore, to convey a correct idea of the destructive

species now under consideration we are necessarily compelled to fall back upon the scientific arrangement and characters of the family, subdivisions, and species. Commencing with the order, we will give briefly the characters of the various divisions and subdivisions leading to the genus *Caloptenus*, to which the Rocky Mountain locust belongs, omitting those divisions and groups not represented in the United States, and referring only to those characters which are most easily recognized, and which apply specially to our acridian fauna.

The *Order* ORTHOPTERA is distinguished from the other orders of the insect *class* chiefly by the following characters: Mouth furnished with mandibles or strong biting jaws; wings four (occasionally wanting), upper pair coriaceous or parchment-like and flexible; under pair thin and membranous, folding lengthwise only in plaits like a fan; transformations incomplete, being active in all stages after hatching from the egg.

Although not as extensive as some other orders, it contains a large number of species which differ very materially in appearance and characters, and are generally known in this country by the common names earwigs, cockroaches, devil's-horses, walking-sticks, grasshoppers, and crickets. Each of these names, except the next to the last, represents a distinct family of the order, thus:

Earwigs ..... Family 1. *Forficulidæ.*
Cockroaches ..... Family 2. *Blattidæ.*
Devil's-horses ..... Family 3. *Mantidæ.*
Walking-sticks ..... Family 4. *Phasmidæ.*
Grasshoppers ..... Family 5. *Acrididæ.*
..... Family 6. *Locustidæ.*
Crickets ..... Family 7. *Gryllidæ.*

As will be seen from this list, there is no confusion between the scientific and common names until we reach "grasshoppers," among which our insect belongs. Other names, it is true, are sometimes applied to insects of the previous families, but with the exception of "earwig" they correspond in their application with the family limits as here given. As before stated, the term "grasshopper" is applied to insects of two families—*Acrididæ* and *Locustidæ;* but notwithstanding this difficulty in using the popular name, the insects which compose the family are easily distinguished from each other by prominent characters.

Locustidæ includes those species usually found on the grass, bushes, and trees, which have very long, thread-like antennæ, generally longer than the body of the insect; the tarsi or feet are four-jointed; the female is furnished at the tip of the abdomen with an exserted ovipositor, usually more or less curved and sword-shaped; and the upper wings of the male are furnished, at the base, with a peculiar arrangement of the nerves, with which, by rubbing them together, they produce sharp, shrill notes. To this family belong the true grasshoppers, the katydids, and

similar insects; it is true there are other species which strongly resemble and are usually called "crickets" that belong to this family.

Acrididæ, includes those species which usually reside on the ground, and are distinguished from those of the other families of saltatorial orthoptera by the following characters:

The antennæ are comparatively short, never exceeding the body in length, and in North American species composed of from twelve to twenty-five joints; the tarsi are apparently three-jointed; the females are furnished at the tip of the abdomen with four short corneous pieces, two of which curve upward and two downward; the male is without the shrilling organ at the base of the wings found in the *Locustidæ*.

This family contains the true locusts, such as those of oriental countries and the Rocky Mountain locust; also such so-called grasshoppers as the common red-legged species of the States and those found hopping on the ground in open waste fields, along roadsides, &c. Therefore, in speaking hereafter of these species, we shall use the term *locust*. As the family contains a very large number of species varying considerably in form and character, entomologists have endeavored to divide it into sections or subfamilies, by bringing together those minor groups having certain characters in common. The various results of these attempts cannot be introduced here, as this would not only require too much space, but also the introduction of matter of purely scientific interest, and of no practical use in this brief review of the classification.

These subdivisions vary in number according to the characters selected by the different authors, some making as many as eleven subfamilies, others only two or three. Yet, as a general rule, the difference is not so much in the grouping as in the value attached to the groups, the subfamilies of one author being considered as subordinate divisions by other authors.

Without undertaking at this time to decide upon the respective merits of these several arrangements, we have selected for present purposes that which makes but three subfamilies, as it appears to be the simplest and most easily understood by general readers. In our descriptions of these subdivisions we shall confine ourselves to those represented in the orthopteral fauna of that portion of North America north of Mexico, and so far as possible select such characters only as are necessary to distinguish these divisions from each other. The first subfamily, *Proscopinæ*, contains only exotic species, and may therefore be omitted from further consideration.

The second subfamily, *Acridinæ*, is distinguished by having the pronotum in the form of a shield, which covers the prothorax and extends backward at farthest only a short distance upon the base of the abdomen, never reaching more than half way to the tip, and seldom half this distance; the prosternum or front breast is drawn up, that is, it is not in the same plane as the rest of the sternum or breast; it is spined,

tubercled, or smooth, but never advanced upon the mouth in the form of a muffler; elytra or upper wings, when present, always as long as the wings; tarsi with pads between the claws.

The third subfamily, *Tettiginæ*, is characterized by having the pronotum, in the form of a shield, extending backward nearly or quite to the tip of the abdomen, and sometimes even beyond it; the prosternum in the same plane as the rest of the sternum, and advanced upon the mouth in the form of a muffler; elytra when present usually shorter than the wings, and placed at the sides of the body; tarsi without pads between the claws.

The two latter families are represented in the United States, but the great body of our locusts belong to the *Acridinæ*, the species of *Tettiginæ* being comparatively few, quite small, and seldom noticed by unscientific observers. As the *Caloptenus spretus* and all other migratory locusts belong to *Acridinæ*, we shall limit our further consideration to this subfamily. It contains several subordinate groups, but the characters by which these are distinguished from each other are not so apparent and uniform as those separating the subfamilies, nor is it necessary for us in this general report to attempt an explanation of these differences. Perhaps we may as well state here that no arrangement we have seen can be considered satisfactory. The form of the head and antennæ, formerly selected as characters, are too indefinite to meet the demands of science, while those adopted by Stål in his most recent arrangement can scarcely be considered of sufficient value or importance to render them more satisfactory; they also fail to separate forms which we think ought not be brought together. To bring together the long conical head, ensiform antennæ, and elongate body of *Truxalis* with the round head, filiform antennæ, and massive bodies of some of the heavier *Oedipodæ*, and to separate such forms as *Pachytylus migratorius* and *Acridium peregrinum*, cannot be justified simply because of the presence or absence of a little prosternal spine or transverse pronotal sulcus. The difficulty arises from the fact that the *Truxalidæ* gradually separate into the two branches represented in part by the *Acridii* and *Oedipodæ*, the transition from the former to the two latter being so gradual that it is almost impossible to mark the dividing line. But any system which fails to recognize the Truxalid group and yet separates the two latter is defective and unsatisfactory.

Therefore, for want of a better arrangement, we adopt for the present the following, although aware that it is defective, but it enables us to eliminate the Truxalid group, which is the only use we wish to make of it at this time.

A. The head conical or pyramidal; the face very oblique, or sloped under toward the breast; the antennæ usually, though not always, enlarged at the base; hind legs comparatively slender. *Truxalini.*

A A. Head more or less ovoid or subglobular; face perpendicular or nearly so, never very oblique, though often somewhat arcuate below; antennæ filiform, subdepressed or clavate, and not enlarged at the base; hind legs generally robust and very distinctly enlarged at the base.

a. Prosternum or front breast armed with a spine or tubercle. *Acridini.*

a a. Prosternum unarmed..... *Oedipodini.*

Although at least one species of *Oedipodini* is migratory in the Old World, and a species in North America (*Camnula pellucida* Scudd.) belonging to the same group was formerly supposed to be the migratory locust of California, yet at present our observations are confined to *Acridini*, which contains the destructive locust of the West. This limits us to those species found in the United States which have the head more or less subglobular or ovoid, and the front breast armed with a spine. The latter character is easily recognized by any one, as the spine may be seen by examining the under side of the neck; it usually stands out like a little blunt thorn, very distinct. If this is wanting, the observer may know without further observation that his specimen does not belong to the migratory species of our country. If it has the spine, and the head is not conical or pyramidal, then he must refer to the characters hereafter given of the genera and species.

We have now reached the genera, which cannot be fully discussed at present, as this would require, if properly done, a revision of the *Calopteni* and *Pezotettigi*, and an examination of all our native species. We will, therefore, simply mention the more important genera of the group represented in the United States, calling attention to a few of the more prominent characters by which *Caloptenus* is separated from those genera most closely allied to it. We will also make use of localities, habits, &c., wherever they will assist the general reader in any way in determining whether or not a given specimen belongs to *Caloptenus*.

The following genera of *Acridii* which are mentioned by North American authors may be omitted from further consideration for the reasons given below:

Tropidacris, *Dictyophorus*, *Rhomalea*, *Ommatolampis*, *Platyphyma*, *Dactylotum*, and *Chromacris*.

The first contains only gigantic species, and if represented at all in the United States, it is only by a single species occasionally found along the southwestern border of Texas.

Rhomalea may be considered as a synonym of *Dictyaphorus*, which is represented by but two subtropical species, which are large, with brightly colored under-wings, chiefly red; while those of our Calopteni are transparent.

Ommatolampis has been superseded by Mr. Scudder's new genus *Hesperotettix*.

Platyphyma and *Chromacris* have probably been introduced by mistake.

Dactylotum has been introduced into our nomenclature for the reception of a very short-winged and brightly-colored species—*Pezotettix picta* Thos.

This leaves only the following genera as necessary to be considered: *Acridium*, *Caloptenus*, *Hesperotettix* and *Pezotettix*.

As *Hesperotettix* contains, so far as we are aware, but three species, easily distinguished from *Caloptenus spretus* by the following characters and facts, it may also be excluded: One is short-winged, green, and found only in the Eastern Middle States; another somewhat common in the West is green, with reddish bands around the femora; the other has so far been found only in Arizona; it is yellow, thickly dotted over with black, and the antennæ annulated with alternate colors.

There is a difference of opinion in reference to the characters of the genera *Caloptenus* and *Pezotettix;* Professor Stål, of Sweden, maintaining that if properly limited *Caloptenus* does not embrace any of our species. He places *C. femur-rubrum*, and consequently the closely allied species, in *Pezotettix*. Without attempting to discuss the question so far as it relates to the proper characters, we have concluded, for reasons which will be mentioned further on, to retain the name *Caloptenus* and to use the genus in the sense understood by American and most European authors. Although the chief distinction between this genus and *Pezotettix*, as adopted in this country, the difference in the length of the wings, cannot be considered satisfactory, yet, as it will answer present purposes, we will avail ourselves of it in order to eliminate the group from consideration. *Acridium*, so far as represented in the United States, may be characterized as follows:

Vertex but slightly inclined, angularly expanded in front of the eyes; antennal grooves profound and extending downward to the clypeus; eyes elongate-elliptical. Pronotum somewhat compressed on the sides, depth usually considerably more than the width, moderately but distinctly expanding behind the last sulcus (very slightly in *rubiginosum*); lateral carinæ obsolete on the anterior lobes, the sides rounding up somewhat as the sides of an arch to the median carina; the dorsum of the posterior lobe more flattened, with the lateral carinæ subdistinct; the lower margin of the lateral lobes straight, the posterior lateral angle slightly obtuse, varying from about 100° to 110°; posterior margin obtuse-angled and rounded at the tip. Elytra and wings, with one exception, considerably longer than the abdomen, and in the exception pass it slightly. Abdomen elongate, rather slender; that of the male not enlarged at the tip; the last segment of the male subconical and distinctly notched at the tip, usually with a square notch; cerci of the male flat, usually broad, oblong, and straight. Prosternal spine, robust, subcylindrical, blunt, and approximating the margin of the mesosternum. The spines of the posterior tibiæ always have at least the basal

portion pale, either yellowish or white, even when the tibiæ are black. Posterior femora long, reaching to the tip of the abdomen, moderately robust, the outer face flat.

The species, with one exception, are large, the females exceeding two inches in length; the exception, *rubiginosum*, is rare in the West, and so far has not been found west of the Mississippi. We have omitted *A. frontalis* Thos., as it does not properly belong to this genus, having been placed here by the author provisionally. As it is green, there is no danger of its being confounded with *C. spretus*. To this genus belongs *A. americanum*, a large reddish-brown species, marked on the outer wings with cellular quadrate fuscous spots, which often does considerable injury to crops in the sections south of the latitude of Saint Louis, which is nearly its northern limit. In 1875 and 1876, and even in 1877, it was seen migrating in considerable numbers, causing much alarm, as those who saw them supposed they were veritable Rocky Mountain locusts. Such flights were observed in Southeast Indiana, Southwest Ohio, Southern Illinois, and Georgia. These flights are very limited in extent, reaching at farthest but a mile or two. Their large size, coloring, generic characters, and southern habitats will readily distinguish them from the *C. spretus*. We may remark here that one of the most destructive migratory species of Southwestern Asia and Northern Africa (*Acridium peregrinum*) is not only congeneric with this species, but so closely resembles it that ordinary observation would scarcely detect the differences between the two.

As before stated, the characters by which the genus *Pezotettix* is distinguished are not satisfactory, and undoubtedly require revision, but in this country the abbreviation or want of wings has generally been adopted as a leading character, which, whether well-chosen or not, is sufficient to distinguish its species from *C. spretus*, which answers our present purpose. This limits us to the genus *Caloptenus*, and the species belonging to it which are found north of Mexico.

As before intimated, Dr. Stål, of Sweden, in his recent work on Orthoptera (*Recensio Orthopterorum*), has so modified the characters of *Caloptenus* (if we admit his *Calliptenus* as a synonym) and *Pezotettix*, that none of our species which have heretofore been placed in the former can be retained, some, as *C. femur rubrum*, *C. spretus*, and closely allied species being referred to a subdivision of the latter genus named by the author *Melanoplus*. He emends the *Calliptamus* of Serville to *Calliptenus*.

If this change is followed, it will add to the confusion of the nomenclature of this group, inflicting on it a host of synonyms where they are already too numerous. If the rule in relation priority require this change, then we might be disposed to submit to it and adopt it, otherwise we prefer to retain those names which by long usage and general acceptance have been woven into all of our entomological and other writings where the insects of this group are mentioned. Let us then

examine this point for a moment, using what Mr. Thomas has stated in his article on Orthoptera in Lieutenant Wheeler's report of his explorations as a basis.

Dr. Stål holds that we have no *Calopteni* in North America, most of the species which have usually been placed in that genus being referable to *Pezotettix*. In his diagnosis of these genera the chief distinctions given are as follows: In *Calliptenus* the elytra are destitute of the intercalate vein; the posterior femora broad and distinctly serrate above; the posterior sulcus in the middle or before the middle.

In *Pezotettix* the elytra are usually abbreviated or rudimentary, and furnished with an intercalate vein; the upper margin of the posterior femora entire and unarmed; posterior sulcus of the pronotum sometimes situated behind the middle.

The genus was established by Serville in 1831, in his article entitled "Revue Methodique des Insectes de l'ordre des Orthoptères," vol. 22, Annales des Sciences Naturelles, with the following as its distinguishing characters:

Calliptamus (καλλος ιπταμαι). Posterior legs longer than the body, robust, and saltatorial. Abdomen firm, neither inflated nor vesicular. Anterior extremity of the prosternum not covering the mouth, the latter [prosternum] having a rather robust, straight, and *obtuse* point [spine]. A pad (rather small) between the tarsal claws. Antennæ filiform, composed of more than twenty cylindric rather indistinct joints. Head vertical, without frontal projection, or having one that is but slightly prominent, and obtuse anteriorly. The middle carinæ of the face with a space between them; sometimes but slightly prominent inferiorly. Ocellus distinct. Tibiæ neither widened or channeled above; lower three-fourths of the upper side with two rows of closely-set spines; first joint of the tarsi elongated. Eyes oval. Pronotum distinctly tricarinate above; lateral carinæ as prominent as the median one; its transverse striæ slightly distinct. Posterior margin more or less rounded. Elytra and wings of ordinary length. Legs robust.

In this genus he included the following species:

1. *C. sanguinipes*, from South America.
2. *C. italicus*, from Africa and Europe.
3. *C. morio*, from Africa, Switzerland, and Pyrenees.

It is evident the author did not base his diagnosis chiefly on *C. italicus*, as some of the characters used are made prominent because of their greater prominence in one of the other of the three species.

Afterward, in 1839, in his *Histoire des Orthoptères*, the same author removed *C. morio* to *Œdipoda*, as it was in fact no Acridian; he also returned *C. sanguinipes* to *Acridium*. He also gave a new diagnosis of the genus, as follows:

Posterior legs robust, much shorter than in the preceding genus (*Acridium*); femora short, much enlarged, very strongly channeled below; tibiæ short, stout, having on the lower three-fourths of the upper side two rows of spines, the basal ones very short; the under side of the femora and upper side of the tibiæ fringed with fine hairs; the terminal spines (or spurs) large, curved. Tarsi straight, furnished with a little pad between the claws; the first joint of the posterior as long as the two last united.

Head large; anterior face vertical; with four distinct carinæ; front a little flattened between the eyes, and also strongly sulcate. Antennæ short, filiform, multiarticulate; joints indistinct, cylindrical. Pronotum short, shagreened, or almost smooth: its disk flat; transverse incisions feeble; dorsal carina distinct, lateral more or less prominent; the posterior border sloped slightly obliquely on the sides; median point somewhat salient. Prosternum furnished in the middle with a strong spine, somewhat enlarged, and very obtuse at the apex. Elytra short, not passing the abdomen, generally equal to it in length. Wings short, not quite the length of the elytra. Eyes large, oblong, slightly prominent. Palpi short; joints cylindrical. Breast large, flat. Abdomen enlarged, strongly unicarinate above; terminal pieces of the female short, as are also the appendages (cerci). Subanal plate of the male somewhat triangular, pointed, and entire at the tip; elevated or straight; appendages of this sex more or less long; sometimes setaceous and curved; in others larger, horny, curved inwards, and truncate at the tip.

Here he divides the genus into two sections, as follows:

First. Abdominal appendages of the male sometimes setaceous, a little curved as the horn of an ox. Subanal plate of the male rather short, elevated. Pronotum shagreened; its posterior median point somewhat prominent.

Second. Abdominal appendages of the male very large, corneous, bent interiorly en cuiller at the extremity, where it is subtruncate. Subanal plate of the male almost straight.

C. italicus is placed in the latter division.

The removal of the two species mentioned above left *C. italicus* as the only original representative of his genus. But in the mean time Burmeister redescribes the genus, and changes the name to *Caloptenus*, including in it as described and understood by him not only *italicus*, but also the American species *femur-rubrum*, *femoratus*, and *bivittatus*, besides a number of other exotic species. This author in his *Handbuch der Entomologie* (1838) describes the genus as follows, giving *Calliptamus* of Serville as a synonym:

A more compressed and yet in general more pleasing structure of the body betrays the members of this genus. Moreover, its head stands entirely vertical, has no noticably prominent apex, and the two median frontal carinæ are united into a flat bulge, which, in the neighborhood of the lower ocellus, is obsolete. The margins of the vertex in front of the eyes are rather sharp, and the part between them is noticeably depressed (sulcate). The strong mouth parts (mandibles) are distinguished, on closer examination, by several pointed teeth on the inner margin. The pronotum has distinctly marked lateral borders (or carinæ), and a sometimes distinctly, sometimes less prominent median line (carina); the posterior margin is more or less salient; and the last of the transverse impressed lines cuts the median carina about its middle. The prosternum has an obtuse vertical spine; the flat meso- and metasternum are broad. Wings and elytra without distinctive characters. Hind femora thick, strongly compressed, with prominent carina above; as long as the abdomen. The male in this genus is especially distinguished by the great development of its genitalia, which causes a spherical thickening of the apex of the abdomen. The terminal ventral plate is, moreover, sometimes large, and envelopes the apex, and sometimes no longer than usual; in the latter case the cerci are very large and curved inward.

In this *C. femoratus*, "from Carolina," appears to be his type; *C. femur-rubrum* being placed next, and *C. italicus* third.

Attention is called to the fact that neither of the authors mentioned alludes to the serratures on the posterior femora, or want of the intercalate vein of the elytra. Serville evidently intended, by some of the characters given in his first description of the genus, to distinguish it from *Pneumora*, belonging to a wholly different group; his pronatal characters are also inapplicable to most of the species which have usually been placed in the genus. Omitting these, nothing remains in his diagnosis but what is applicable to a number of other genera.

Taking these facts into consideration, we are forced to consider the *Caloptenus* of Burmeister, although given but as an emendation of Serville's *Calliptamus*, as really a new genus. This being the case, *C. femur-rubrum* must be retained as the type, unless *femoratus* is considered a good species.

It is also worthy of remark that Seville's genus does not appear to have been adopted or used by any other author previous to the publication of Burmeister's *Handbuch*. On the contrary, Brulle (Hist. Nat., 1835); O. G. Costa (Fauna di Napoli, 1836), and Hahn (Icon. Orthop., 1835), retain *italicus* in *Acridium*.

The character of *Caloptenus* and *Pezotettix*, as given by H. Fischer, (Orthoptera Europea, 1853) were evidently intended to embrace only European species, and although we infer from his remarks that he would include our species of Calopteni in the former genus, yet the characters render it very doubtful where they would fall.

Therefore, while we admit that the group stood sadly in need of revision at the time Stål entered upon the work, yet we do not think the facts warrant him in dropping the generic name *Caloptenus* or in removing *femur-rubrum* therefrom, hence we cannot follow him in this change. This is, perhaps, not a proper place to discuss a question of this kind, but we have considered it necessary to say this much in explanation of our reasons for differing with so distinguished an entomologist in his special field as Dr. Stål.

Under the circumstances it is perhaps best that we should define the genus as we understand it, or at least give the characters which the North American species have in common which we include in *Caloptenus*. These are as follows:

CALOPTENUS, Gen. char.

Head subglobular, front vertical, or nearly so. Eyes ovoid, sometimes almost suborbicular, but usually the length is to the breadth as three to two, and the front side is more or less straightened; usually the upper canthus is more or less angular, but sometimes it is rounded so as to obliterate the angle; generally rounder and more prominent in the male than in the female; separated above by a little less than their width. Vertex narrow between the eyes, the width at this point being a little less than the width of the eye; usually though not always sulcate, the sulcus or groove shallow; expanding slightly, abruptly, and angularly immediately in front of the eyes; deflexed (15° to 40°), and generally rounded in front. Frontal costa usually quite prominent, about as broad as the vertex between the eyes; sides parallel; flat, or shallowly sulcate,

reaching to or nearly to the clypeus. Pronotom subquadrate, that is to say, a cross section (in the middle) will present a quadrate figure or parallelogram with the upper corners slightly rounded; the sides are nearly perpendicular; the disk or dorsal surface is very nearly flat, with a little thread-like, median carina, usually distinct on the posterior lobe, but sometimes obliterated on the middle and anterior lobes; the lateral carinæ are obtuse, but distinctly marked as the angle where the disk and sides meet; on the posterior lobe they sometimes appear as true carinæ, though not prominent or sharp; the lower margin of the sides is nearly straight, sometimes projecting a little in the middle, where the triangular corner piece connects; the posterior lateral margin varies somewhat; in some species it forms a distinct entering angle at the shoulder or lateral carina, in others it continues to the tip in an almost straight line; the three transverse incisions are distinct and situated close together, the posterior one being a little behind the middle and always cutting the middle carina; all three sever the lateral carinæ, but the anterior one ends at the upper margin of the sides with a slight and short curve forward; the posterior and middle ones extend down the sides well toward the lower margin, and most generally about midway down the posterior sends out at right angles a branch sulcus which often crosses the intermediate space to the middle one; there is also a fourth sulcus extending down the sides close to the anterior margin; the posterior sulcus and usually the middle one make a short curve forward immediately at the median carina; the posterior margin is obtuse-angled, rounded at the tip; the posterior lobe is usually finely punctured, while the middle and anterior lobes have a velvety or felty appearance.

The elytra and wings extend to or beyond the tip of the abdomen; the former are narrow (except in *C. bivittatus*); the latter transparent in all our species; sometimes a very slight greenish-yellow or a bluish tinge is observed, the nerves usually more or less dark. The abdomen is usually subcylindrical, presenting no distinct keel above; that of the male enlarged at the tip and curved upward; the cerci are usually flat, rounded at the tip, and curved up but some are straight and others tapering. The last abdominal segment, which curves upward like the prow of a boat, is sometimes truncate above, sometimes with a slight angular notch. Posterior femora robust, much enlarged near the base, the external face more or less convex, in the female never longer and generally shorter than the abdomen; in the male the reverse is the rule. Pads between the claws large, reaching a maximum size in some of the species. Most of our species have the upper portion of the inner face of the posterior thighs marked with three oblique dark bands (the one at the base often indistinct). There is generally a dark stripe on the side running back from the eye to the last transverse sulcus of the pronotum; it is often interrupted, broken, or partially obliterated, but is seldom wholly wanting in those species any way closely allied to *C. spretus* or *C. femur-rubrum*. The antennæ are filiform and slender, reaching their maximum length in the male of *C. differentialis*, where they sometimes attain the middle of the body. The prosternal spine is usually stout and conical, quadrangular at the base, and generally slightly transverse; in one or two species it approximates the mesosternum, but this is not usual.

Our species vary in length from 6-10 to 2¼ inches.

The genus as thus characterized is represented in the territory embraced in our observations by a number of species, several of which are so closely allied to *C. spretus* that it is difficult for any but an experienced entomologist to determine to which a specimen belongs. We think it more than likely that future investigations will show that several of the species which have been described as distinct are but varieties of other closely-allied species.

The following list contains all the species found in the United States

which have been described up to the present time, except a few mentioned by older authors, which have not been identified in recent years:

C. femur-rubrum, Deg.
spretus, Thos.
atlanis, Riley.
repletus, Walk.
bilituratis, Walk.
punctulatus, Uhler.
lurida, Dodge.
minor, Scudd.
gracilipes, Scudd.
deletor, Scudd.

C. robustus, Scudd.
Turnbullii, Thos.
floridanus, Thos.
angustipennis, Dodge.
plumbum, Dodge.
bivittatus, Say.
differentialis, Thos.
griseus, Thos.
scriptus, Walk.
occidentalis, Thos.

C. Yarrowii, Thos.
regalis, Dodge.
fasciatus, Scudd.
helluo, Scudd.
devorator, Scudd.
ponderosus, Scudd.
flavolineatus, Thos.
Keelerii, Thos.
volucris, Dodge.

Although this list of species is somewhat large, it will be necessary to call attention to but few of them, as the larger number can easily be disposed of by reference to locality or a single character.

C. spretus, or Rocky Mountain locust, as will hereafter be more fully shown, is a comparatively small species, the body seldom exceeding one inch and a quarter in length, slender, the elytra or upper wings longer than the body, of a pale brownish color, with small squarish darker spots arranged along the middle line; body some shade of brown, never distinctly green or bright yellow, and without pale or yellow stripes along the back.

By referring to locality, we may eliminate the following species:

C. floridanus and *Keelerii*. So far only found in Florida.

C. griseus. With spots scattered over the elytra; rare, and hitherto discovered only in Ohio.

C. bivittatus. A widely-dispersed species, much larger than *spretus*, with two yellow or pale stripes along the back.

C. differentialis. Our largest species belonging to the genus, one and a half to two inches long, without spots on the elytra.

C. Turnbullii. Dull yellowish-brown, with two broad yellow stripes; wings scarcely as long as the abdomen.

C. repletus and *scriptus*. Hitherto found only in northwest part of Washington Territory.

The following species are local in the places mentioned, and are distinguished by having the last abdominal segment of the male rounded or squarely truncate at the tip, whereas that of *spretus* is notched:

C. plumbum, Nebraska; tip of male abdomen rounded.

C. ponderosus, Texas; tip of male abdomen rounded.

C. robustus, Texas; tip of male abdomen rounded.

C. devorator, Texas; tip of the male abdomen truncate.

C. deletor, Texas; tip of the male abdomen rounded.

C. glaucipes, Texas; tip of the male abdomen acuminate but rounded.

C. fasciatus, Texas and Nebraska; tip of the male abdomen rounded.

C. minor, Nebraska; very small; tip of the male abdomen tuberculate.

C. lurida, Nebraska; last ventral segment of the male entire.

C. volucris, Nebraska; terminal segment of the male abdomen pointed at the tip; elytra unspotted.

Some of these are doubtless good species and may be found to be more widely distributed than our present knowledge would indicate. Some of them are most probably local offshoots or varieties of *femur-rubrum*.

C. helluo is from Texas; the female only has been observed, and has the spots on the elytra scattered throughout.

C. regalis has been observed at only one locality in Nebraska, is very distinct, being marked to a greater or less degree with bluish and white; disk of the elytra white, and veins of the wings white; hind tibiæ bright blue, with a white annulus near the knee.

C. Yarrowii is known only by a single female, probably from Arizona, but possibly from Nevada; elytra brown, with oblong yellow spots along the disk, scarcely as long as the abdomen.

C. flavolineatus, from Southern California, is evidently very closely allied to *spretus*, and in all probability is but a southwest or Pacific coast variety of it. It is distinguished from that species by being somewhat fleshier, shorter wings, and its bright yellow lines. The last ventral segment of the male is very slightly notched.

C. angustipennis has been observed only in Nebraska, and is evidently a local variety of *C. atlanis*; in fact, the characters given scarcely justify its being designated as a variety.

C. punctulatus, found in New England, is probably nothing more than a sectional variety of *femur-rubrum*.

C. occidentalis, found west from Minnesota to Colorado, although possessing distinctive characters, is probably nothing more than an offshoot from *femur-rubrum*, not like *atlanis* in the direction of *spretus*.

C. bilituratus, Washington Territory, has been observed at but one or two points.

This leaves but three species, *femur-rubrum*, *spretus*, *and atlanis*, which require special mention in this connection, as they are the only ones generally distributed which are so closely allied to each other as to render it difficult to distinguish them.

Caloptenus spretus, Thomas.

As every fact relating to the history and habits of this species is either of economic or scientific interest, we give here a brief history of its nomenclature.

About 1860, Mr. Thomas, then residing in Southern Illinois, sent some specimens of Orthoptera collected in that locality to Mr. P. R. Uhler, of Baltimore, Md., for determination; among those returned was one marked *Acridium spretis*, with a note stating that it was new.

In a paper written by Mr. Thomas on "Insects injurious to vegetation in Illinois," in 1862, but not published until 1865 (Trans. Ill. St. Agl. Soc., V), he describes a species of locust under the name *A. spretis* Uhler, as follows:

General color a dark, brownish purple, with dusky points and lighter rays. Head brown, with dusky points; antennæ reddish yellow. Thorax an ashy brown, with a

velvety luster on the anterior half, the latter half punctured; the lower edges, at the sides, paler—sometimes pale red, at others almost white. Elytra extending about half over the abdomen (or not exceeding two-thirds), marked along their internal margins with a light, reddish-brown ray; external margin dusky; a few dusky dots along the internal margins. Wings not quite as long as the elytra; transparent, pale yellowish on the disk, tinged with red at the base (in recent specimens). Posterior thighs crossed by two black bands, and black at the knees; intermediate spaces pale yellow—often almost white. Length of female, one inch and three-eighths; of the male, slightly over an inch.

This species is quite common here along the road-side and among low weeds and grass.

Immediately after this, in the same paper, follows a brief description of *femur-rubrum*, showing that he then considered the two species as distinct. But there is evidently some mistake in his description; although it agrees in part with the characters of *spretus*, part of the description cannot possibly apply to that species. The original specimens were destroyed soon after the paper alluded to was written, and Mr. Thomas is unable at present to explain the error, and knows of no species in Southern Illinois to which the description will apply throughout. It is more than probable that there was some confusion of specimens at the time the description was written. It is possible that one or more of the three specimens "*a. b. c.*" (Walker's Cat. Dermap. Salt.) of the British Museum are from the collection made by Mr. Thomas at that time.

In the "Practical Entomologist" (October, 1866), Mr. Walsh notices this species somewhat at length under the name of *Caloptenus spretus*, quoting Mr. Uhler as authority, but gives no further description than a comparison of the length of the wings with those of *C. femur-rubrum*.

In Mr. Scudder's "Catalogue of the Orthoptera of North America," published in 1868, it is mentioned under the name *Acridium spretum* Uhler.

No description of the species having been published previous to the appearance of the "Synopsis of the Acrididæ of North America," Mr. Thomas described it as follows:

Very much like *C. femur-rubrum*, Burm., the principal difference being in the length of the elytra and wings, a notch at the tip of the last (♂) ventral segment. Posterior lobe of the pronotum slightly expanding; median somewhat distinct. Elytra and wings pass the abdomen about one-third their length. The last (♂) ventral segment, which is turned up almost vertically, is somewhat tapering and is notched at the apex, which distinguishes it from the *femur-rubrum*; the notch is small, but is distinct. Prosternal spine, robust, subcylindrical, transverse. Migratory.

Color.—Scarcely distinct from the *C. femur-rubrum*. The occiput and disk of the pronotum generally reddish-brown; the posterior lobe somewhat paler than the anterior and middle. Spots as in *femur-rubrum*, arranged in a line along the middle of the elytra; these are a little larger and more abundant toward the apex. The head and thorax are sometimes a very dark olive-brown, at others reddish-brown and even brownish-yellow, the color deepening with age. The wings are pellucid, nerves dusky toward the apex; when flying high and against the sun their wings look like large snow-flakes.

Dimensions.—♀ Length (to tip of abdomen) 1 to 1.2 inches; elytra as long as the body; posterior femora, 0.55 inch; posterior tibiæ, 0.5 inch. ♂ Length, 0.85 to 1 inch; elytra, 0.9 to 1.05 inch.

This must, therefore, be accepted as the first description of the species.

In the Report of the Geological Survey of the Territories for 1871 (published in 1872), he described the pupæ as follows:

General color, yellow (sometimes varied to light-brown, and at others a pale pea-green), with a large proportion of black spots and stripes, also a few white dots and lines; labrum and lower part of the face, mostly black; upper part of the face, the vertex and cheeks yellow (or the prevailing color); a row of black dots on each margin of the broad, sulcate, frontal costa; occiput with two lateral and one median dotted lines of black; a broad line of deep black starts behind each eye and crosses over the entire length of the pronotum, widening and bowing upward near the middle of the pronotum; the immature, somewhat fan-shaped elytra [wing-pads] are black, with a white dot on the disk near the base, from which proceed about ten or twelve white rays, the dorsal or upper margin yellow; dorsal and lateral portions of the abdomen varied with white and black; a triangular black dot on each side of each segment; tip and venter yellowish.

In his "Seventh Annual Report" (1875), Mr. Riley gives the following additional characters of the perfect insect from living specimens, also the following descriptions of the larva and pupa:

Regarding coloration, as with *femur-rubrum*, it is quite variable, and the dead specimens convey a very imperfect idea of the living colors, which are thus given in my notes taken in the field. The more common specimens are yellowish-white beneath; glaucous across the breast and about mouth-parts; pale bluish-glaucous, often with shades of purple, on the sides of the head and thorax and on the front of the face; olive-brown on the top of the head and thorax; pale beneath, more or less bluish above, and marked with black, especially toward base, on the abdomen. The front wings have the ground-color pale grayish-yellow inclining to green, and their spots and veins brown; the hind wings, except a yellowish or brownish shade at apex and along the front edge, and a green tint at base, are transparent and colorless, with the veins brown. The front and middle legs are yellowish. The hind legs have the thighs striped with pale glaucous and reddish on the outside and upper half of inside, with four broad black or dusky marks on the upper edge, the terminal one extending beneath around the knee. The shanks are coral-red with black spines; the feet somewhat paler with black claws; antennæ, pale yellow; palpi, tipped with black. In the dead specimens all these colors become more dingy and yellow. Palpi and front legs in some specimens tinged with red or blue; the hind tibiæ sometimes yellowish instead of red, especially in the middle.

Larva.—When newly hatched the larva is of a uniform pale gray without distinctive marks. It soon becomes mottled with the characteristic marks, however. After the first molt the hind thighs are conspicuously marked on the upper outside with a longitudinal black line; the thorax is dark with the median dorsal carina and two distinct lateral strips pale yellow, the black extending on the head behind the eyes. The sides of the thorax then become more yellow with each molt, the black on the hind thighs less pronounced, and the face almost always black. The occiput and abdomen above are mottled with brown, the former marked with a fine median, and two broader anteriorly converging pale lines, the latter with two rather broken lateral lines of the same color.

Pupa.—The pupa is characterized by its paler, more yellow color, bringing more strongly into relief the black on the upper part of the thorax and behind the eyes; by the spotted nature of the face, especially along the ridges, by the isolation of the black subdorsal mark on the two anterior lobes of prothorax, and by the large size of the wing-pads which, visible from the first molt, and increasing with each subsequent molt, are now dark, with a distinct pale discal spot, and pale veins and borders. The hind shanks incline to bluish rather than red, as in the mature insect.

The following somewhat full description of the perfect insect is given from a comparison of a large number of specimens from different sections:

Female.—The face nearly perpendicular, sloping under, toward the breast very slightly; a few of the specimens reared in confinement form a somewhat marked exception to this character, sloping under (by measurement) 36° from perpendicular, while a deflexion of 15° appears to be the extreme of those collected. Vertex between the eyes same width as the frontal costa just above the central ocellus, and distinctly less than the shortest diameter of the eyes; the fastigium, or portion of the vertex in front of the eyes, more or less distinctly channeled, and deflexed at an angle of about 40° from horizontal. Eyes nearly straight in front from the upper to the lower canthus, about semicircular behind. Antennæ quite slender, and rather short, reaching only to or but slightly beyond the tip of the pronotum.

Pronotum short, the anterior portion scarcely as broad as the head; sides of the anterior lobes parallel, the posterior lobe expanding somewhat rapidly posteriorly; the median carina threadlike, but always distinct on the posterior lobe, usually obsolete on the anterior lobes; lateral carinæ obtuse but distinct on the posterior lobe, usually so on the middle lobe but becoming obsolete toward the front; posterior lateral margin perpendicular from the humeral angle one-third its length then curves forward to the posterior lateral angle which is obtuse and rounded; the (entering) humeral angle is sharply defined, and in this respect appears to differ from *C. femur-rubrum* and *C. atlanis;* the apex is obtuse, angled (about 100°) rounded at the point; posterior lobe minutely and shallowly punctured throughout, anterior lobes smooth with few or no punctures except along the lower margin of the sides. Elytra and wings extending beyond the tip of the abdomen from one-fourth to one-third their length (see measurements given below); the elytra are of nearly uniform width throughout, slightly curving upward at the apex, the thin portion (that part in which the branch nerves curve upward) occupying about two-fifths of the length; wings a little shorter than the elytra, very thin and delicate; nerves and nervules very slender. Abdomen, and in fact the whole insect, rather more slender than usual in this genus, but this appearance is partly due to the elongated wings; cerci very small, triangular or tooth-shaped, not extending across the segment on which they rest; the valves of the ovipositor quite prominent, especially the upper pair which are more than usually exerted, sharp at the tips, and deeply excavated above. The posterior femora usually extend about to the tip of the abdomen, and are rather slender in comparison with some other species of the genus.

Color.—Reddish-brown with fuscous spots. Head and the pronotum back to the posterior sulcus reddish-brown varying in depth in individuals; the face is sometimes of a lighter and brighter red than the pronotum, sometimes darker assuming a dark purplish hue; the posterior lobe of the pronotum is generally a pale, olive brown, its lighter color contrasting somewhat distinctly with the darker shades of the anterior portion; some individuals exhibit much lighter colors than here described, varying from a very dark brown to a dull yellow. Specimens which have but recently entered the perfect state often show on the posterior lobe traces of the dark longitudinal lines seen in the pupa. The dark line on the side of the head and pronotum usually so conspicuous in the closely allied species is generally obliterated in this species by the dark brown color, but it usually appears distinctly in specimens which have been immersed for some time in alcohol, and is also manifest in the pale individuals, but is broken up by pale spaces and lines. The eyes are shining black. Elytra ash-brown, more or less tinged with reddish-brown at the base and fading toward the apex; in the disk or middle field, commencing near the base, where this field comes to a point, is an irregular row of fuscous dots, usually single to where the thin portion commences, now and then a double dot appearing; from this point to the apex they decrease in size and distinctness and spread over the entire width; as a general rule the

inner field (posterior marginal area) is marked with a few fuscous dots; in some individuals one or two quite distinct are seen, in others they are very minute and dim, and not unfrequently they are entirely wanting. Wings transparent, with a very slight yellowish tinge at the base; nerves and nervules of the costal area and apical portion black, rest pale. The abdomen is generally glossy brown with the posterior margins of the segments pale; venter yellowish or pale brown; sternum pale brown or dull yellow. Anterior and middle legs usually more or less rufous but varying from reddish-brown to pale honey-yellow. Posterior femora with the disk reddish-brown, sometimes showing dim outlines of oblique bands; the inner face and lower carina yellowish, the latter usually tinged with red; the upper carina and upper portion of the inner face yellowish, marked with three large black spots or partial bands, one at the base, the other two equally spaced in the middle portion; apex or knee black or with a black crescent each side.

The posterior tibiæ vary in color from a bright coral red to pale yellow, and in some cases to bluish.

Measurements (these are given below).

Male.—Differs from the female as follows: Is somewhat smaller, the average difference in the length of the body being shown by the measurements given below; the wings are nearly or quite as long as in the female; it is also somewhat slenderer, but these differences are too slight and variable to be of any value as characteristics; the abdomen is enlarged or widened posteriorly and curved upward at the apex; the last ventral segment being elongated, rounded and narrowed upward like the prow of a boat, and at the tip is distinctly notched, the lobes somewhat tubercular in form; this part of the apical segment is covered with minute scattering hairs. This notch forms one of the chief characteristics of the species, at least the most important one in distinguishing it from *femur-rubrum*. The supra anal plate, or triangular piece above the anal opening, is sharply bicarinate longitudinally; the tooth-like appendages at the base, above, are narrow and slender. The cerci are somewhat longer than the width of the preceding segment, are broad and flat throughout, the width equalling two-thirds the length; not suddenly narrowed or constricted, moderately curved upward and inward; roundly narrowed and depressed near the apex. The prosternal spine (in both sexes) is sub-quadrate and large at the base but distinctly transverse, robust and decidedly conical, gradually lessening to a blunt point.

Measurements of the female (from Riley's Seventh Report).

Whole length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.	Whole length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1.25	0.28	0.15	0.13	1.48	0.38	0.15	0.23
1.23	0.33	0.18	0.15	1.28	0.38	0.15	0.23
1.28	0.40	0.23	0.17	1.30	0.36	0.13	0.23
1.34	0.30	0.12	0.18	1.29	0.36	0.12	0.24
1.38	0.40	0.22	0.18	1.30	0.42	0.18	0.24
1.29	0.24	0.06	0.18	1.33	0.28	0.04	0.24
1.33	0.28	0.19	0.19	1.35	0.32	0.08	0.24
1.44	0.38	0.19	0.19	1.33	0.39	0.15	0.24
1.25	0.39	0.19	0.20	1.30	0.42	0.18	0.24
1.38	0.43	0.23	0.20	1.35	0.43	0.19	0.24
1.24	0.33	0.13	0.20	1.26	0.30	0.06	0.24
1.25	0.32	0.12	0.20	1.38	0.40	0.16	0.24
1.15	0.33	0.13	0.20	1.33	0.36	0.12	0.24
1.35	0.42	0.20	0.22	1.24	0.33	0.08	0.25
1.28	0.40	0.18	0.22	1.29	0.38	0.13	0.25
1.30	0.40	0.18	0.22	1.45	0.43	0.18	0.25
1.33	0.43	0.20	0.23	1.50	0.43	0.18	0.25
1.29	0.28	0.05	0.23	1.33	0.33	0.08	0.25
1.35	0.33	0.10	0.23	1.30	0.43	0.18	0.25
1.16	0.36	0.13	0.23	1.30	0.33	0.08	0.25

Measurements of the female—Continued.

Whole length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.	Whole length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1.25	0.30	0.04	0.26	1.38	0.42	0.13	0.29
1.30	0.35	0.09	0.26	1.35	0.42	0.13	0.29
1.28	0.32	0.06	0.26	1.36	0.39	0.10	0.29
1.34	0.30	0.04	0.26	1.29	0.38	0.09	0.29
1.36	0.34	0.08	0.26	1.38	0.43	0.14	0.29
1.25	0.38	0.12	0.26	1.28	0.38	0 09	0.29
1.45	0.52	0.16	0.26	1.33	0.39	0.10	0.29
1.45	0.44	0.18	0.26	1.36	0.34	0.04	0.30
1.25	0.30	0.04	0.26	1.45	0.43	0.13	0.30
1.39	0.45	0.18	0.27	1.38	0.33	0.03	0.30
1.52	0.40	0.13	0.27	1.35	0.40	0.10	0.30
1.26	0.36	0.09	0.27	1.38	0.39	0.08	0.31
1.28	0.40	0.13	0.27	1.29	0.35	0.04	0.31
1.28	0.35	0.08	0.27	1.38	0.35	0.03	0.32
1.33	0.33	0.06	0.27	1.42	0.48	0.16	0.32
1.33	0.35	0.08	0.27	1.30	0.40	0.18	0.32
1.28	0.35	0.08	0.27	1.43	0.38	0.06	0.32
1.26	0.39	0.12	0.27	1.25	0.35	0.03	0.32
1.38	0.42	0.15	0.27	1.46	0.44	0.12	0.32
1.30	0.40	0.13	0.27	1.33	0.36	0.04	0.32
1.23	0.35	0.08	0.27	1.24	0.36	0.03	0.33
1.43	0.30	0.02	0.28	1.34	0.45	0.12	0.33
1.29	0.36	0.08	0.28	1.35	0.43	0.10	0.33
1.28	0.38	0.10	0.28	1.35	0.45	0.10	0.35
1.30	0.36	0.08	0.28	1.32	0.38	0.03	0.35
1.35	0.43	0.15	0.28	1.33	0.38	0.03	0.35
1.30	0.43	0.15	0.28	1.43	0.45	0.10	0.35
1.33	0.38	0.10	0.28	1.38	0.42	0.04	0.38
1.38	0.42	0.13	0.29	1.53	0.49	0.10	0.39
1.15	0.38	0.09	0.29				

Later measurements of the female.

Length to tip of elytra.		Length to tip of elytra.	
Iowa specimens	1.23	Montana specimens	1.20
	1.15		1.25
	1.27		1.31
	1.08(?)		
	1.38	Average	1.25
	1.30		
	1.20		
	1.25		
	1.26		
	1.26	Colorado specimens	1.34
	1.27		
	1.21		
	1.22		
	1.32		
	1.21		
	1.24	Dakota specimens	1.23
	1.20		1.15
	1.21		1.17
	1.15		1.30
	1.29		1.30
	1.22		
Average	1.24	Average	1.23
Idaho specimens	1.40		
	1.35		
	1.22	Specimens reared by Miss Middleton from eggs from Minnesota	1.32
	1.34		1.20
	1.29		1.18
Average	1.32	Average	1.23

Measurements of the male (Riley's Seventh Report).

Length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.	Length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1.24	0.25	0.05	0.20	1.35	0.34	0.03	0.31
1.20	0.28	0.08	0.20	1.30	0.34	0.03	0.31
1.29	0.28	0.08	0.20	1.33	0.33	0.02	0.31
1.18	0.33	0.12	0.21	1.25	0.34	0.03	0.31
1.26	0.25	0.03	0.22	1.32	0.34	0.03	0.31
1.22	0.29	0.06	0.23	1.30	0.34	0.03	0.31
1.10	0.29	0.05	0.24	1.18	0.34	0.02	0.32
1.33	0.29	0.04	0.25	1.38	0.40	0.08	0.32
1.31	0.35	0.09	0.26	1.38	0.42	0.09	0.33
1.24	0.29	0.03	0.26	1.40	0.38	0.05	0.33
1.29	0.35	0.08	0.27	1.28	0.38	0.05	0.33
1.30	0.32	0.05	0.27	1.30	0.35	0.02	0.33
1.30	0.35	0.08	0.27	1.24	0.38	0.04	0.34
1.28	0.35	0.08	0.27	1.30	0.38	0.03	0.35
1.29	0.32	0.05	0.27	1.40	0.38	0.03	0.35
1.24	0.30	0.03	0.27	1.33	0.35	0.00	0.35
1.19	0.33	0.06	0.27	1.33	0.38	0.03	0.35
1.28	0.36	0.09	0.27	1.35	0.38	0.02	0.36
1.28	0.30	0.02	0.28	1.34	0.38	0.02	0.36
1.24	0.38	0.09	0.29	1.29	0.38	0.02	0.36
1.35	0.39	0.10	0.29	1.33	0.35	0.02	0.37
1.23	0.38	0.09	0.29	1.36	0.43	0.06	0.37
1.35	0.35	0.05	0.30	1.38	0.34	0.05	0.39
1.35	0.40	0.10	0.30	1.33	0.36	0.03	0.39

Later measurements of the male.

Length to tip of elytra.		Length to tip of elytra.	
Iowa specimens	1.20	Colorado specimens	1.31
	1.23		1.40
	1.15		1.28
	1.17		1.25
	1.26	Average	1.31
	1.18		
	1.19		
	1.18		
	1.28		
Average	1.205		
		Dakota specimens	1.19
Montana specimens	1.21		1.21
	1.21	Average	1.20
	1.30		
Average	1.24		
Idaho specimens	1.28		
	1.26	Reared by Miss Middleton from eggs	1.19
	1.21		1.24
Average	1.26	Average	1.215

The species most closely allied to *spretus* is the *C. atlanis*, Riley, which the author describes in his seventh report, as follows:

Length to tip of abdomen 0.70–0.85 inch; to tip of closed wings, 0.92–1.05 inches. At once distinguished from *femur-rubrum* by the notched character of the anal abdominal joint in the male, and by the shorter, less tapering cerci; also by the greater relative length of the wings, which extend, on an average, nearly one-third their length beyond the tip of the abdomen in the dried specimens; also by the larger and

more distinct spots on the wings, in all which characters it much more closely resembles *spretus* than *femur rubrum*. From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax, and of the pale line from the base of wings to hind thigh; and also by the anal joint in the male, tapering more suddenly, and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts; the colors thus more strongly contrasting.

* * * Just as the typical *femur-rubrum* is at once distinguished from the typical *spretus* by the characters indicated, so *atlanis*, though structurally nearer to *spretus*, is distinguished from it at a glance by its much smaller size and darker, more marbled coloring. The contrast is all the greater in the living specimens of *spretus* that at all approach it in these respects.

Measurements of the male.—Length to the tip of the elytra, 0.97, 0.95, 0.98, 0.95, 0.96, 0.84, 1.05, 0.93.

C. femur-rubrum, De G.

This species is also closely allied to *spretus* and *atlanis*, and as it has often been described, we will here simply refer to the differences between it and the former of these two (*spretus*).

Female.—The only very marked difference between the females is the shorter wings of this species, yet there are other slight variations observable when a large number of specimens are compared, such as the following: The eyes in *femur-rubrum* are slightly more prominent; the head, pronotum, and sides of the thorax are usually some shade of olive-brown, varying from pale to almost black; the black line behind the eyes is quite broad, seldom broken up, and is distinct in the darkest specimens. The humeral (entering) angles of the posterior margin of the pronotum are more rounded and not so sharply defined as in *spretus;* the median carina is usually more distinct on the anterior lobes, while the lateral carinal are rather more obtuse and not so well defined; the punctures on the posterior lobe are more distinct. The wings extend but slightly beyond the extremity of the abdomen (see measurements below). In this species and *atlanis*, the intercalate vein is present in the elytra (notwithstanding the assertion of Stål to the contrary), dimly and imperfectly it is true, but it can be clearly seen for more than half the length of its course; in *spretus* it is wanting, its place being marked by the line of union between the two rows of cells. The fuscous spots or dots are not so conspicuous or widely spread over the apical portion of the elytra and the elytra are narrower and straighter.

As a very general rule, the upper half of the external face or disk of the posterior femora is black or brown, the lower margin and lower half of the inner face bright coral-red; when these colors are well defined, there is a yellow space or stripe between the red and black; but these markings are subject to considerable variation, the red sometimes being entirely wanting, the external face dark, and the lower margin yellow; sometimes the dark is replaced by a pale olive. The tibiæ are most generally bright red, but this character is not without its exceptions. Usually there is a pale ray extending from the base of the wings to the posterior coxa, but is occasionally wanting in dark specimens and is generally absent in *spretus*. The prosternal spine is not so distinctly quadrate at base as in *spretus*, transverse, flattened behind, and not regularly conical, but more uniform in size to the broadly-rounded and very blunt apex.

Male.—The most constant difference between the species is found in the form of the last ventral segment of the male; in *femur-rubrum* this segment, although strongly curved upward as in *spretus*, is not so distinctly narrowed toward the end but rounded, and instead of being notched at the tip is squarely truncate, presenting a sharp, horizontal, and almost semicircular margin. Below the tip on the posterior face of the

segment is a rather large transverse gash-like indentation. The cerci are about the same length as those of the male *spretus* and about the same width at the base, but are narrowed from the middle to the tip to about half the width at the base. The little tooth-like appendages at the base of the super-anal plate are elongate and slender, as in *spretus* and are sinuate.

Measurements of the female (Riley's Seventh report).

Length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.	Length to tip of elytra.	Length of elytra beyond base of tibia.	Length of abdomen beyond base of tibia.	Length of elytra beyond tip of abdomen.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1.22	0.13	0.15	0.00	1.06	0.10	0.03	0.07
1.15	0.13	0.15	0.00	1.09	0.10	0.03	0.07
1.05	0.04	0.05	0.01	1.13	0.10	0.03	0.07
1.08	0.09	0.10	0.01	1.15	0.10	0.03	0.07
1.20	0.13	0.14	0.01	1.15	0.08	0.00	0.08
1.15	0.03	0.03	0.01	1.12	0.08	0.00	0.08
1.03	0.04	0.04	0.01	1.14	0.15	0.06	0.09
1.10	0.06	0.05	0.01	1.18	0.09	0.00	0.09
1.06	0.03	0.02	0.01	1.10	0.13	0.04	0.09
1.06	0.03	0.02	0.01	1.16	0.12	0.03	0.09
1.08	0.03	0.02	0.01	1.19	0.23	0.12	0.11
1.08	0.04	0.03	0.02	1.15	0.14	0.03	0.11
1.05	0.03	0.02	0.02	1.13	0.12	0.00	0.12
1.09	0.06	0.04	0.02	0.95	0.03	0.03	0.00
1.15	0.14	0.12	0.02	1.05	0.04	0.03	0.01
1.04	0.02	0.00	0.02	1.00	0.03	0.02	0.01
1.08	0.02	0.00	0.02	1.03	0.04	0.03	0.01
1.04	0.03	0.00	0.03	1.03	0.04	0.03	0.01
1.09	0.08	0.05	0.03	1.03	0.05	0.03	0.02
1.03	0.03	0.00	0.03	0.98	0.02	0.00	0.02
1.08	0.12	0.09	0.03	1.08	0.05	0.03	0.02
1.04	0.03	0.00	0.03	0.97	0.02	0.00	0.02
1.10	0.06	0.03	0.03	1.06	0.10	0.08	0.02
1.13	0.14	0.10	0.04	1.03	0.04	0.02	0.02
1.13	0.08	0.04	0.04	0.94	0.02	0.00	0.02
1.08	0.04	0.00	0.04	1.05	0.08	0.05	0.03
1.13	0.09	0.05	0.04	1.10	0.09	0.06	0.03
1.18	0.12	0.08	0.04	1.02	0.03	0.06	0.03
1.13	0.09	0.05	0.04	1.04	0.05	0.02	0.03
1.15	0.13	0.08	0.05	1.10	0.08	0.04	0.04
1.09	0.08	0.03	0.05	0.95	0.09	0.05	0.04
1.15	0.13	0.08	0.05	0.99	0.08	0.04	0.04
1.19	0.15	0.10	0.05	1.05	0.08	0.04	0.04
1.19	0.14	0.09	0.05	1.08	0.09	0.05	0.04
1.04	0.05	0.00	0.05	1.08	0.10	0.06	0.04
1.19	0.14	0.08	0.06	1.09	0.08	0.03	0.05
1.15	0.14	0.08	0.06	0.99	0.05	0.00	0.05
1.18	0.08	0.02	0.06	1.04	0.05	0.00	0.05
1.18	0.14	0.08	0.06	1.05	0.06	0.00	0.06
1.13	0.09	0.03	0.06	1.12	0.12	0.05	0.07
1.13	0.09	0.02	0.07	1.05	0.08	0.00	0.08

A few additional measurements of last year's specimens:
Female—1.21, 1.23.
Male—1.05, 0.94, 1.02, 1.05, 1.07, 1.07.

In addition to the characters mentioned in the original description of *C. atlanis*, we would call attention to the following differences between it and *spretus* on the one side and *femur-rubrum* on the other.

Female.—As compared with the female of *spretus* the wings are shorter, extending less and sometimes beyond the tip of the abdomen, not differing greatly, in this respect, from *femur-rubrum;* the elytra are narrower, curved upward very slightly at the apex, very few spots or dots on the apical portion, and these minute and dim. The inner field is almost always immaculate, the posterior half of the intercalate

vein apparent. The wings pellucid, but when living have next the base a bluish-white tinge; a larger portion of the nerves and nervules dark. The black stripe on the side of the head and pronotum nearly always apparent, even in the darkest individuals; head and anterior lobes of the pronotum with the velvety appearance, so marked in *spretus*, but here dark or olive brown, without the reddish cast so common in that species; the pale, oblique, metathoracic ray usually apparent, but often obliterated.

There are no reliable characters by which to distinguish it from the female of *femur-rubrum;* the posterior lobe of the pronotum is usually less conspicuously punctured, agreeing in this respect with *spretus.*

Male.—Differs from *spretus* in being smaller, pronotum rather more constricted and subcylindrical; eyes more rounded and prominent; the notch at the tip of the last ventral segment less distinct, sometimes almost obliterated; more of the nerves of the wings dark.

From the male of *femur-rubrum* it differs in usually having longer wings; in some individuals they are as long, proportionably, as in any specimen of *spretus;* in others, little or no longer than in *femur-rubrum;* in the more slender form, and smaller size; in having the apical segment of the abdomen narrowed and notched at the tip; in having the cerci broad throughout, and shaped as in *spretus;* in having the tooth-like appendages at the base of the super-anal plate shortened and broadened, and with a longer union at their base.

It is evident from these characters that *atlanis* is an osculant species (or variety) intermediate between *spretus* and *femur-rubrum*, partaking largely of the characters of each, and, in a few respects, differing from both. The female approaches very near *femur-rubrum*, scarcely showing varietal differences from the female of that species, while on the other hand the male approaches much nearer *spretus* than it does *femur-rubrum*, as shown by the character of the terminal segment, the form of the cerci, and the length of the wings. The local species heretofore mentioned, which belong to this restricted group are, in all probability, offshoots from *spretus* or *femur-rubrum*, the particular direction of the variation depending upon the peculiar condition of the locality.

The popular names of these species are as follows:

C. femur rubrum has generally been and is still known as the "Red-legged locust" or, which is better, the "Common Red-legged locust."

C. atlanis was first described from the New England States, but as the species is not confined to the Atlantic slope, and the term Atlantic might convey a wrong idea, we have concluded to call it the "Lesser locust," in reference to its smaller size.

C. spretus is known by several popular names, as "The Hopper," "Army grasshopper," "Red-legged locust," "Mormon locust," "Western locust," "Hateful grasshopper," and "Rocky-Mountain locust." The last name, which Mr. Riley suggested as the most appropriate, is now generally adopted, and has been accepted by the Commission.

CHAPTER II.

CHRONOLOGICAL HISTORY.

The history of the American or Rocky Mountain locust is in nearly all respects parallel with that of the locust of the Old World. It breeds over a large continental area, and periodically, in seasons of extreme drought and other favoring meteorological conditions, migrates in immense hordes for several hundred miles beyond its usual habitat. Unlike the locust of the Eastern Hemisphere, our species naturally affects the cooler and more elevated portions of the temperate zone in the New World, though its southern limits extend at times into the hot and dry plains of the Great Basin.

Fitful and periodical in its visits to the older, settled portions of the West, the history of the Rocky Mountain locust is difficult to trace beyond a period of about thirteen years. Previous to the year 1864 it has been rarely referred to by travelers in the West, and after examining the reports of the government expeditions and the works of Lewis and Clark, Pike, Irving, and others, we find little or no mention made of it. It is a question in our mind whether in some regions it may not have increased in numbers since the Far West has been partially settled, particularly in those regions where irrigation has been practiced, as in Utah and Colorado and in the western edge of the Mississippi Valley, as in Nebraska, Kansas, Iowa, and Minnesota; but this is entirely uncertain, and it is more reasonable to suppose that as the Western Territories become more thickly settled the numbers of locusts will become diminished.

In treating of the history of locust invasions, we will first consider the subject in a very general way, and then state the facts more concisely, arranged according to separate States and Territories; and, thirdly, present a summary of the subject in a tabular view. The latter is calculated to send a chill to the agricultural heart when one sees how dense the figures are from 1864 until 1877, and to lead one to infer that the evil is waxing greater and greater as the years go on. This may be due, however, to the greater extent of the country settled and to the fact that the population is growing denser and denser. However that may be, we shall deal with facts and not with theories, and would remind the reader that in a number of the years there recorded large harvests resulted, the injury done by locusts being local and only confined to a portion of the season, while in 1877 the largest wheat harvest ever grown was safely harvested.

Leaving out of account the locust visitations in the Atlantic and Pacific States, which were made by different species from the Rocky Mountain locust, the first authentic statement is to be found in Neill's

History of Minnesota, wherein it is stated that in 1818 and 1819 vast hordes of grasshoppers appeared in Minnesota, eating everything in their course, in some cases the ground being covered three or four inches thick. In the same years they were destructive in the Red River country in Manitoba. In 1820, or the succeeding year, they ravaged the western counties of Missouri, and Riley[1] suggests that the 1820 swarms may have also ravaged Kansas and the neighboring regions northward. In 1842, locusts appeared in Minnesota and Wyoming; in 1845, in Texas; in 1846 and 1847, in the limits of what is now Wyoming; and in 1849, in Texas, and possibly in Minnesota. In Utah they have appeared from 1851 until 1877, except only the years 1873 and 1874, and a glance at the table shows that this Territory is liable to suffer annually more or less, especially in the northern portion.

Vast swarms of locusts were seen in Idaho in 1852, as well as in Utah, while Dakota was visited, or had native swarms, in 1853. The year 1854 was a year for locusts in Texas, Kansas, and Utah, and 1855, notable for locust ravages on the Pacific coast, was not a bad year east, Texas only having been invaded, although A. S. Taylor states that they abounded on the immense grassy prairies lying on the eastern slopes of the Rocky Mountains, a statement supported by no facts, so far as we can learn.

In the year 1856, however, locusts prevailed in Texas, Kansas, Iowa, Minnesota, possibly Wyoming and Utah, and in the succeeding year they committed extensive ravages in Manitoba, and the States mentioned as suffering in 1856, with the addition of Nebraska. The States of Texas and Nebraska received slight injury from the progeny of those that migrated thither the previous two years.

In 1860, the region about Topeka, Kans., was visited by what must have been a limited and rather local swarm.

The year 1861 witnessed the presence of locusts in Nebraska, Montana, and Utah, but the accounts are scanty.

Montana and Utah sustained losses from locusts in 1862, but in 1863 they occurred not only in those Territories, but also in Dakota and Minnesota.

But the most decided increase in the numbers of locusts was felt in 1864, a year of general visitation in Utah, Montana, Dakota, Colorado, portions of New Mexico, and east of the plains in Nebraska, Iowa, Minnesota, as well as Manitoba, and there were resulting swarms, in most cases the progeny of those which came in 1864, in Iowa, Minnesota, Dakota, and Manitoba, while Montana, Colorado, and Northern New Mexico had swarms of their own.

A notable locust year was 1866, and, as Riley states, the injury committed was sufficiently great and wide-spread to attract national atten-

[1] Seventh, Eighth, and Ninth Reports on the Noxious, Beneficial and other Insects of Missouri. By C. V. Riley, State Entomologist, 1875–'77. The following history is largely taken from these reports, sometimes word for word.

tion. "The insects swarmed over the Northwest and did great damage in Kansas, Nebraska, and Northeastern Texas, and invaded the western counties of Missouri very much as they did in 1874. They came, however, about a month later than in that year. They were often so thick that trains were seriously delayed on account of the immense numbers crushed on the track." Iowa, Minnesota, Colorado, and Utah also suffered.

While in 1867 local damage was done in the spring by the young of the swarms of the previous year, late in the summer new swarms flew across the plains from the West and Northwest and invaded the border States; in fact, the same States suffered as in 1866, as will be seen by a glance at the tabular view.

In 1868 and 1869, local injuries ensued from the ravages of the unfledged locusts early in the season, and reports from Montana, Idaho, Dakota, Colorado, and Utah show that there was some trouble in those Territories.

The year 1870 was a season of comparative immunity from locust invasions, though Iowa and Minnesota received some swarms, and the insects were observed in Dakota, Idaho, Wyoming, and Utah.

Kansas received slight injury from these pests in 1872, as well as Minnesota, Dakota, Montana, Colorado, and Utah, but it was not marked.

In 1873, the hosts gathered for a fresh onslaught upon the agricultural region bordering the great plains. The invasion of 1873, says Riley, was pretty general over a strip of country running from the northern parts of Colorado and southern parts of Wyoming, through Nebraska and Dakota, to the southwestern counties of Minnesota, and northwestern counties of Iowa, the injury being most felt in the last two more thickly settled States. "The insects poured in upon this country during the summer and laid their eggs in all the more eastern portions reached. The cry of distress that went up from the afflicted people of Minnesota in the fall of that year is still fresh in mind, and the pioneers of Western Iowa, in addition to the locust devastations, suffered severe damage from a terrific tornado."

By far the most disastrous locust year, however, was 1874, as the more thickly settled portions of the Mississippi Valley west of the ninety-fourth meridian were invaded by dense and most destructive swarms. The States of Colorado, Nebraska, and Kansas were overrun, while portions of Wyoming, Dakota, Minnesota, Iowa, Missouri, New Mexico, Indian Territory, and Texas were ravaged by swarms from the northwest, as they were abundant that year in Montana and in British America. The loss to these States and Territories was estimated at not much less than $50,000,000. Much of the loss this year resulted from the progeny of the invaders of 1873, which early in the season devoured the crops of the region where they hatched, and eventually spread to the southeast. Kansas suffered, perhaps, more heavily than any other State. This, like most other locust-years, was one of long-continued drought, and in Missouri the evil was complicated by the ravages of the chinch-bug.

The next year (1875) the young hatched in immense numbers over an area variously estimated at from 250 to 350 miles from north to south and from 200 to 270 miles from east to west, embracing portions of Nebraska, Kansas, and Missouri. "The tract in which the injury done by the destructive enemy was worst was confined to the two western tiers of counties in Missouri, and the four tiers of counties in Kansas, bounded by the Missouri River on the east. The greatest damage extended over a strip 25 miles each side of the Missouri River, from Omaha to Kansas City, and then extended south to the southwestern limit of Missouri. About three-quarters of a million of people were, to a greater or less extent, made sufferers. The experience of different localities was not equal or uniform. Contiguous farms sometimes presented the contrast of abundance and utter want, according to the caprices of the invaders, or according as they hatched in localities favorable to the laying of the eggs. This fact gave rise to contradictory reports, each particular locality generalizing from its own experience. The fact is, however, that over the region described there was a very general devastation, involving the destruction of three-fourths of all field and garden crops. While the injury was greatest in the area defined above, the insects hatched in more or less injurious numbers from Texas to British America, the prevalence of the insects in Manitoba being such that in many parts little or no cultivation was attempted." (Riley.)

Missouri had never before been visited by a calamity so appaling and so disastrous in its results as the locust ravages of 1875, and detailed returns of the damage done in this State showed a loss of over $15,000,000. (Riley.)

In 1876 no trouble was experienced in the spring, there being in the border States little damage done by the young, except in portions of Minnesota and Colorado, and it was hoped that no further losses would ensue this year. But locusts bred in great quantities in Montana, and in British America, north of this Territory, and in Wyoming, Dakota and Colorado, this being a year of unusual drought in those Territories, and in August and the autumn following, immense swarms swept over the plains, falling upon the larger part of Kansas and Nebraska, the western half of Iowa, and some of the western counties in Missouri, and reaching into the Indian Territory, Texas and the northwest corner of Arkansas. Besides this, local swarms hatching in Minnesota early in the year flew south and southwest into Iowa and Nebraska, and they laid eggs in August.

The spring of 1877 opened with dismal prospects all over the States east of the plains, as well as in Colorado. Happily it was a spring in which there was an unusual rain-fall in April, May, and June, the country along the Missouri being flooded in places. The weather was also exceptionally cool; and this condition of things extended over Colorado, Northern Utah, Wyoming, Central Montana, and British America. In consequence of this season of wet and cold, the young grasshoppers

died in immense numbers wherever they hatched, and comparatively few lived to acquire wings. South of the parallel of 40° they flew, late in May and early in June, in a general northwest and northerly course; and from Minnesota and Iowa many took flight to Dakota and Montana, whence their progenitors came, and others remaining behind flew about irregularly in the States of Minnesota and Iowa.

The outlook for 1878 is excellent; but still there may be light swarms from the northwest if the season is favorable. We will now give a more detailed history of locust invasions in the different States and Territories.

THE LOCUST IN TEXAS.

The list of locust-years in Texas is rather a formidable one. The earliest year recorded is 1845.

1845.—We have accounts from various sources of their swarming in Texas this year. (Riley's seventh report.)

1847.—Mr. S. J. P. McDowell states that locusts made their appearance in Caldwell County October 1, 1847, and remained during the fall, but did little damage. The county officials of Caldwell County have kept in their county records a diary of the appearance of the grasshoppers in that county since their first appearance, in 1847.

1849.—Riley states, also, that there are various accounts of locusts in Texas this year.

1854.—About ten or fifteen miles, as near as we can calculate, from Fort Belknap, April 25, 1854, locusts were observed by the members of Captain (now General) Pope's expedition, as it is stated that "the whole section of country is covered over with grasshoppers in countless myriads. They were very troublesome, and at night they completely filled our tents. They appear to be going south; and if they do so, increasing in strength and numbers, an incalculable amount of injury will be inflicted on the farmer. The day was remarkably warm." (J. H. Byrne's Diary of Capt. John Pope's Expedition, Pacific Railroad Surveys, vol. ii, Appendix A, p. 87.)

1855.—Mr. Taylor, in his article in the Smithsonian Report for 1858, states that locusts this year infested "those portions of the State of Texas which resemble in physical characteristics Utah and California." We have, however, been unable to obtain any corroborative data, except the statement of Mr. Reveschon; but the fact that he states that they were in Texas in the following year is confirmatory of his statement.

1856.—Locusts are said to have existed in Texas in small numbers this year. (Taylor.) Mr. Reveschon writes that "I came into this [Dallas] county in February, 1856. The fall previous a great number of grasshoppers made their appearance," and destroyed a field of thirty acres.

1857.—November 6, locusts appeared in Caldwell County, coming

from the west, destroying turnips, &c. As we have full information given below regarding the hatching of locusts in Texas, there is good reason to believe that swarms visited the region where the eggs were hatching in 1858 in the previous year more extensively than any published accounts state.

1858.—The following facts regarding the ravages of locusts in Western Texas, in 1858, are taken from the Gonzales Inquirer for 1858. The young locusts began to hatch "by the million," January 16, and by the middle of March they had done extensive damage to the wheat and garden crops. March 27, on the San Marcos and Guadalupe Rivers, and on the Sandies, they did great damage to the corn crops and gardens." They seem to have collected together, and are moving in a southward direction, sweeping everything in their route. As yet, they are not more than half grown, and can only travel by the leaping system, their wings not having grown out. Large flocks of birds are not only devouring them, but it is said they are actually devouring each other. After doing great damage, April 21–May 8 they flew in a northeast or northward course. By May 8, they had mostly disappeared, and almost wholly so by the 15th. So complete and so general has been the destruction that all the farmers will be compelled to replant. In the spring of 1858, they destroyed our growing crops and took their flight north from 10th to 16th of April. (D. A. Todd, Austin, Tex.) In Caldwell County the young began to disappear about April 20.

1866.—Locusts appeared in the northwest part of Collins County about the 1st of September, destroyed all the wheat that had come up, and then passed on to the southwest. They had nearly disappeared in October. (Monthly Report Ag. Dept., 1866, p. 441.)

1867.—The young hatched in threatening numbers, but a cold snap during the first week in May destroyed them. Nearly a dozen counties were invaded in the autumn. In Dallas County the locust first appeared October 17, the air being filled with them. "They appeared to be coming from the west and traveling east." In October they also appeared in Fannin, Red River, Bell, Coryell, Lavaca, Burleson, Fayette, Austin, and Lampasas Counties, appearing in the latter county" in immense numbers about the first of October, and completely destroyed the autumn and winter gardens, and injured the stock-range materially. They continued with us until the 20th, when they moved on their journey in a southeasterly direction. In Lavaca County they deposited their eggs "by the million." In Coryell County, central Texas, they appeared October 12, "coming in vast quantities from the north," and proved very destructive to grain and garden produce. Mr. Affleck, of Brenham, states that locusts appeared there in the first week of November, "but were announced toward the northwest of us as being on the way some weeks before." They were busy about the first of December depositing their eggs. They appeared at Union Hill, five miles to the west of Mr. Affleck's farm, for a week before appearing at the latter

place, and were two weeks longer in reaching Brenham, seven and a half miles to the south by east. (Riley's seventh report.)

1868.—The young hatched out in the spring, but were destroyed by the heavy rains. Mr. Affleck states that they began to hatch early in February, and by the 28th of March began to move in bands in or near Brenham, Glenblyth Valley, and injure gardens. By April 23, vast numbers of locusts went off. "Some of them got off by flight, but the bulk kept on on foot toward the northwest, followed and preyed upon by hundreds of black hawks, or rather buzzards—I think the *Falco harlani*." No swarms of "emigrant" locusts arrived from the Northwest in the autumn. Two observers, however, at Calvert, agree in stating that locusts appeared there in the autumn of 1867 and 1868. There are no records of the appearance of locusts after this until about the year 1872 or 1873.

1872?—That locusts probably invaded Texas during 1872, and each year following until 1876, will be seen by the following extracts from reports from United States weather signal observers, forwarded by the Chief Signal-Officer, United States Army, at the request of the Commission:

"They visited this section in 1876, and for five or or six years previous." (E. G. Prince, Fredericksburg.)

"Visited every year twice since about four or five years." (J. C. Rickli, Mason, Tex., June 13, 1877.)

"Of late, for three or four years, they came to Western Texas every year. They arrived in the latter part of September, during October, and kept coming till November, till the first frost put a stop to their wanderings." (J. C. Rickli, Mason, Tex., July 12, 1877.)

These data may refer to 1872, but we leave the matter in doubt until more exact information is received. The following statement, however, tends to show that there was an invasion in 1872, as locusts are reported as existing in small numbers in the spring of 1873. If these were not native species, then there must have been a slight invasion of *C. spretus* in 1872.

"This section was visited by small numbers of these insects in the spring and autumn of 1873 and 1875, and from October 1 to 15, 18[7]6. None the present year." (William Norrington, United States Signal Service, Uvalde, Tex.)

1873.—"In September, 1873 [no specified date], there appeared at this place, suddenly, immense swarms of locusts, coming from a northerly direction. The direction of their flight followed the Rio Grande River for about thirty miles in its course to the Gulf. For about five days the multitudes kept traveling over this place, descending to the ground at sundown and remaining below until shortly after sunrise the next morning, when all would rise in a body and resume their flight. The weather during this visitation was very dry and sultry, and the prevailing wind northerly; the damage done immense. These locusts

left an immense amount of eggs behind, which, at the beginning of spring—*i. e.*, the latter part of January in this section—began to hatch. Then it was discovered that the eggs had been laid over a tract of country nearly two miles wide, having the Rio Grande River for its center, and following its course out to what distance I am unable to ascertain." (Frederick Belford, United States Signal Service, Eagle Pass.)

1874.—Mr. Belford continues his statement regarding the progeny of the locusts which invaded Texas in 1873: "The wingless insects were harmless in the early stages of their growth, but as their development proceeded, the work of devastation began. In the first part of May, 1874, they began to move—not flying, but crawling. The fact has been observed that the movements of these swarms of young locusts were in exactly the opposite direction to which their progenitors had traveled. They seemed to retrace the steps of their ancestors. Those hatched on this side of the Rio Grande River moved north toward the settlements, and on their way everything in the shape of vegetation was totally consumed. Those hatched on the Mexican side of the Rio Grande (they extended a mile and a half on each side of the river) took a direction west of north, and the work of devastation was equally great in the parts of Mexico they passed over. I am assured on good authority that when leaving this section they were too young to fly, and their march was carried on by crawling and hopping. Toward the latter part of May, 1874, all had left, and planting was begun. Now, these young locusts, before leaving, had deposited eggs, but the eggs of the young ones are not very plentiful and sparsely distributed. The people of this section, while this occurs, do not mind it much, as the damage done by this not very numerous offspring is never considerable."

At Denison they arrived in September, 1874. (United States Signal Office.) September 14, 1874, locusts appeared in Dallas County, but, according to Mr. Boll, were not one-tenth as abundant as in 1876; still they destroyed all the young vegetation, and injured the fall wheat to some extent. "All this month they laid countless millions of eggs, about as many as in 1867. At the end of this month most had disappeared traveling in a southern or eastern direction. (G. Reveschon.)

1875.—It seems by the extract from Mr. Belford's statement, that the young hatched this year from eggs laid in the late autumn of 1874 did but little injury to crops. He adds, "In September, 1875, another large swarm of locusts made its appearance, coming from the same direction, *i. e.*, north, but their numbers were not as formidable as those of the previous year. These insects deposited their eggs, which were hatched the ensuing spring, *i. e.*, latter part of January, 1876. The numbers of the young ones coming forth was comparatively insignificant, and having in their turn deposited their eggs, they left about the first half of May, 1876, in a northerly direction. (F. Belford, Eagle Pass, United States

Signal Office.) At Denison, locusts arrived in September, 1874, remaining until June, 1875. (W. A. Massey, United States Signal Office.)

Uvalde was visited by small numbers of locusts in the spring (young) and autumn of 1873 and 1875, and from October 1 to 15, 1876. Laredo was visited in 1875 and 1876, appearing each year about the beginning of November. (United States Signal Office.)

1876.—Swarms of locusts reached Texas from the north and west, about the middle of September, and from that time forth till winter were flying very generally over the State, reaching eventually latitude 29°, or, more definitely, to the Gulf all the way from the Sabine River to Austin. Their course was almost due south, and their injury confined to succulent vegetables, shrubs, and fruit-trees, the orange and cotton suffering more particularly. At Austin the cars for about ten days were so much obstructed on the Texas Central Railroad line as to necessitate their stopping occasionally to clear the track of the grasshoppers. Eggs were laid throughout the territory overrun, and the young hatched in large quantities during the mild weather of February, but those which hatched near the Gulf had up to the date of March 5 been destroyed by heavy cold rains that occurred the latter part of February. (Riley's ninth report.) The invading swarms began to arrive late in August, and continued to come for six weeks, and the course of their flight was generally due south; others state that they came from the northwest. From reports received from the Office of the Chief Signal-Officer, United States Army, we extract the following statements: "In the fall of 1876, they went down to Eastern Texas, as well as to the western part of the State. Everything in the line of vegetables was destroyed, fruit-trees and grape-vines damaged more or less. Small winter grain is preferred to grass, and mostly destroyed." At Dallas, they first arrived September 20, from the northwest; the swarm was estimated to be 2,000 feet high, and from forty to sixty miles wide. (J. Boll.) "The area invaded by the grasshoppers in Texas, in the fall of 1876, was embraced between longitude 96° and 99° (west from Greenwich, or 19° and 22′ west from Washington). It extended entirely across the State, from Red River on the north to the Gulf of Mexico on the south, covering six degrees of longitude, or an area about 200 miles in width by 360 in length, or 72,000 square miles; this belt extends through the center of the State from north to south, between parallel lines, with somewhat irregular edges, determined by the course of the wind at different times during their 'march to the sea.' By reference to the map of Texas, it will be seen that the best agricultural portion of the State was covered by them."

1877. The spring was mild in Texas, and the young hatched the latter part of January, in February, and the last ones in March. From March 1 to 10, at Mason, they did the most mischief, and began to fly away by the 10th of May, but a good many remained until the 15th. "It is said this pest grows worse and worse every year, and will eventually ruin the farmers if something is not done to check them. After

fighting with the climate, poor soil, late frosts, and heavy droughts, they have still to fight the grasshoppers in this arid section of country. Twice a year, in the spring and fall, the growth of vegetation is checked by them to a fearful extent." (J. C. Rickli, Mason, Tex., United States Signal Service.)

At Corsicana, eggs were announced to be hatching the 5th of February, but most numerously about the 20th of February, and on the smooth, barren sandy spots. The young insects acquired wings the first of May and commenced migrating as soon as winged, and were most numerous from the 9th to 12th of May, and disappeared about the 20th of May. Wheat suffered most; corn least. Fruit and vegetables were greatly injured. The injury will not exceed 10 per cent. (J. W. Smith, United States Signal Service.) This account is confirmed by other United States observers in different parts of the State. At Pilot Point, the United States signal-observer states: "On the last of April and first of May, clouds of locusts alighted, flying from the south with, a brisk south wind, and staid over night and one day, eating large fields of wheat and corn, and then, rising, resumed their northward flight"; and again under date of May 25, "Clouds of them are flying northward at the present time, and most all have left this portion of the country. * * * Since the hoppers have left, the vegetation has come out again and the farmers are hard at work replanting their fields, and as far as I can understand, the crops will prove favorable this season, considering the damage done."

A slight invasion took place in the autumn of this year, as may be seen by the following extract from the report of J. C. Rickli, United States signal-observer at Mason: "October 30, 1877. High temperature, with wind veering to northwest and north, increasing in velocity to 32 miles per hour and bringing the first Rocky Mountain locusts in their swarms at 4 p. m. They pursued their southern course, and did not deposit any eggs in this section."

"On the 3d of October, 1877, in the afternoon, myriads of grasshoppers were seen passing over this station about two or three hundred feet high, coming from the north and going south; wind was from northwest and four miles an hour; temperature 72°, fair weather. Their flight continued the 4th, but there were more of them apparently. None were observed on the 5th; wind from south, 4 miles an hour, and cloudy; temperature about 62°. On the 6th, they resumed their journey, going south, though in small numbers. Temperature about 75°; fair weather; wind from southeast, four miles an hour. During their flight none came down. (E. G. Prince, Fredericksburg, United States Signal Service.)

A correspondent at Headsville, Robinson County, states that "about the last of August, immense numbers passed over our county, but high up in air." From Helotes, Bexar County, we learn that, "on September 28, 29, and 30, swarms passed over this county, but, so far

as I can understand, none have laid eggs, or even lighted on the ground."

The United States signal-observer, C. A. Smith, Galveston, sends the following facts regarding the presence of locusts in that portion of Texas, principally copied from the Galveston Daily News. Hatching began January 25, but the young appeared most numerously between February 15 and March 1, and by the 10th of that month they were observed hopping in bands in almost every instance northward. In Gronzales County they were seen flying northward about April 15, becoming fledged about April 5, and in other counties about the 20th to 25th. In Austin County, on April 30th, "the heavens were clouded with them, going north, the wind being south." In other counties they migrated northward; for example, in Falls County there were "millions passing over, flying northward, about May 2. They disappeared in different counties from May 5 to 16. No eggs were deposited during the present year.

"The damages were at first reported as severe, from nearly all of the central counties of the State, but many of the devastated grain fields entirely recovered after the departure of the insects." Mr. Smith concludes "that the damage to the grain crops in the sixty-four counties visited cannot exceed 5 per cent. Gardens everywhere appear to have sufferred to a much greater extent than the grain crops. They are reported as having been entirely destroyed in a large number of cases, and were badly damaged wherever visited. He estimates $790,350 as the approximate damage to gardens.

THE LOCUST IN INDIAN TERRITORY.

While it is most probable that Indian Territory was visited in nearly the same years as Texas and Missouri, the records are very meager. In 1874 portions were visited according to the reports of the Agricultural Department.

In 1875 locusts hatched out in large numbers early in the spring. The signal-service observer at Fort Gibson reports that there were three distinct swarms seen about the 1st of May, which seemed to originate from eggs laid the previous year. During the month of May they departed in a generally north and west direction. A dispatch from Fort Gibson, dated June 1, states that "millions of locusts flew westerly. The Grand, Verdigris, and Arkansas Rivers were covered with the dead hoppers that failed to fly across at the start."

In 1876, at Fort Gibson, they appeared September 16 to 28. (United States Signal Service.) Mr. Riley states that "they were thick over most of the Territory, passing southward, from the middle of September, and many of them remaining through the season." Locusts were not observed at Fort Sill, either in 1876 or 1877. (United States Signal Office.) Fort Gibson was not visited by locusts during the summer of 1877, but from April 13 to May 1, the young hatched out in great numbers, but

died from the effects of "the long-continued cold rains occurring shortly after the eggs began to hatch." "No young locusts were seen after the 14th of May. None of the locusts arrived at maturity, neither were any seen off their hatching-grounds." (United States Signal Office.)

THE LOCUST IN ARKANSAS.

The first recorded instance of locusts extending into this State was, according to Mr. Riley, in 1876. They overran the extreme northwest corner of the State, and were particularly injurious in Benton County, the damage being mostly confined to this county and the region south of it, the insects not extending east to Carroll County. "They made their advent from the 7th to the 15th of October, coming with the wind from the northwest and flying south and southwest, until they struck the base of Boston Mountain. As in our own [Missouri] southeast counties, wheat was greatly injured by them, and eggs were laid up to the time winter set in." (Riley's ninth report.)

In 1877, Arkansas was again visited, but to what extent is unknown. The only data at hand are the following statements from correspondents: At Bentonville, Benton County, "A few passed over the last days of September, and a very few alighted in some localities." Again it is stated that "fresh swarms passed over from the northwest, but none settled." At Carrollton, Carroll County, no swarms were noticed during the present year, though they passed over in the autumn of 1876.

THE LOCUST IN MISSOURI.

The history of the invasion of this State by the Rocky Mountain locust has been so fully set forth by Mr. B. D. Walsh, in his Illinois report, and by Mr. Riley, in his seventh, eighth, and ninth annual reports on the injurious insects of Missouri, that the following account is simply a brief abstract of their statements, the portions quoted being in most cases taken from Mr. Riley's report.

1820 or 1821.—In one of these years, it is uncertain which, Western Missouri was visited by locusts. "They came in the autumn by millions, devouring every green thing, but too late to do much harm. They literally filled the earth with their eggs, and then died. The next spring they hatched out, but *did but little harm*, and when full-fledged left for parts unknown. Other districts of country have been visited by them, but, so far as I could learn, they have done but little harm after the first year. (Prairie Farmer, June 15, 1867.) This statement is corroborated by the following: "A Missouri paper publishes a statement by an old settler, that great numbers of grasshoppers appeared in September, 1820, doing much damage. The next spring they hatched out, destroying the cotton, flax, hemp, wheat, and tobacco crops; but the corn escaped uninjured. About the middle of June they all disappeared, flying off in a southeast direction. (*Western Rural*, 1867.)

1866.—The next recorded invasion took place in 1866, when the west-

ern counties of Missouri were overrun much as in 1874. "They came, however, about a month later than in 1874. They were often so thick that trains were seriously delayed on account of the immense numbers crushed on the track." (Walsh's Illinois Report.) Innumerable eggs were deposited in the autumn.

1867.—Serious damage was done by the young locusts in the spring, particularly about Saint Joseph and Oregon. By the middle of July they had nearly all left the State. A fresh, though less extensive invasion, swept over Nebraska and portions of Kansas and the western borders of Iowa and Minnesota, or, in Walsh's words, "the main body descended through Nebraska upon Iowa, instead of through Kansas upon Missouri," but the extreme northwest corner of Missouri was overrun by the swarms, which were said to have come from the Rocky Mountains.

1868.—Considerable injury was done by locusts this year in the following counties: Andrew, Cedar, Clinton, Daviess, Gentry, Jackson, Nodaway. There was, however, no fresh invasion from the west.

1869.—Early in the season of this year locusts troubled the western borders of Missouri. "They hatched out in countless numbers from the 20th to 24th of March in Holt County. In Andrew County the young, where the ground was smooth and hard, as 'sod' or prairie that was plowed in the previous June, and not afterward plowed, destroyed most of the wheat. * * * Our own stock was bad enough, but on the 18th of June we received a large addition of flying ones from the south, which in some places took half of the corn, although they left on the 23d of June, staying less than five days. They came with a strong south wind, and while here the north wind blew, and if they were disturbed they would work a little south; but on the 23d, at 11 a. m., the south wind blew and they rose simultaneously and most of them left us; but our original stock not being able to fly remained. There are no records of the presence of locusts in Missouri in 1870, 1871, 1872, or 1873.

1874.—The locust visitation of this year was the most calamitous to Missouri, as to the neighboring States, of any yet recorded. A map of the area overrun this year, as compared with 1866, is given in Mr. Riley's seventh report. He states that the general direction from which they came was from the northwest. They reached Holt County on the 8th of August, and all the counties on the same line, north and south, from Worth to McDonald, were reached during the latter part of the same month. They then continued to make short flights, and finally reached their extreme eastern limit toward the last of September. They flew no farther east than in 1866, except in the northern part of the State, and only visited the western fourth or fifth of the State. The swarms appeared during early August, and in most of the counties invaded, the locusts stayed till frost, *i. e.*, from their first appearance till frost swarms came and left, so that there were most always

some of them about. The injury in Missouri was comparatively slight compared with that done in 1874 in Kansas.

1875.—"Serious and distressing," says Mr. Riley, "as were the ravages of this insect in 1874, when the winged swarms overswept several of the Western States, and poured into our western counties in the fall, the injury and suffering that ensued were as naught in Missouri compared to what resulted from the unfledged myriads that hatched out in the spring of 1875." The spring was propitious to the young, few adverse causes tending to reduce their number being in operation. "The winter of 1874–'75, though commencing late, was severe, steady, and protracted till toward the first of May, when spring suddenly came upon us in full force. There was no very variable weather in the earlier months; whereas such weather did occur in 1867." Besides this the summer seasons of 1873 and 1874 were dry and hot. The worst injury was done in the two western tiers of Missouri. "The greatest damage extended over a strip twenty-five miles each side of the Missouri River, from Omaha to Kansas City, and then extending south to the southwestern limit of Missouri."

"Early in May the reports from the locust district of the State were very conflicting; the insects were confined to within short radii of their hatching-grounds. The season was propitious, and where the insects did not occur, everything promised well. As the month drew more and more to a close, the insects extended the area of destruction and the alarm became general. By the end of the month the non-timbered portions of the middle western counties were as bare as in winter. Here and there patches of *Amarantus blitum* and a few jagged stalks of milkweed (*Asclepias*) served to relieve the monotony. An occasional out-field or low piece of prairie would also remain green; but with these exceptions one might travel for days by buggy and find everything eaten off, even to underbrush in the woods. The suffering was great and the people well-nigh disheartened. Cattle and stock of all kinds, except hogs and poultry, were driven away to the more favored counties, and relief committees were organized. Many families left the State under the influence of the temporary panic and the unnecessary forebodings and exaggerated statement of the pessimists. Chronic loafers and idlers even made some trouble and threatened to seize the goods and property of the well-to-do. Relief work was, however, carried on energetically, and with few exceptions no violence occurred. Early in June the insects began to leave; the farmers began replanting with a will. As the month advanced the prospects brightened, and by the 4th of July the whole country presented a green and thrifty appearance again. The greatest damage occurred in the counties bordering on the Missouri River to Liberty, and thence southward; and Bates, Buchanan, Barton, Clay, Cass, Clinton, Henry, Jackson, Johnson, Lafayette, Platte, Saint Clair, and Vernon suffered most. The other counties in the district invaded in 1874, and especially those along the eastern borders of

that district, suffered less. In some of these, as the extreme northwest counties, the reason may be found in the fact that the winged insects of 1874 did not stay long enough to lay excessive numbers of eggs; while in those along the eastern border the reason is to be found in the fact that the winged swarms when they reached this limit were weakened and decimated; they were the straggling remains of a vast army."

1876.—The counties ravaged by the young insects in 1875, had splendid crops in 1876. Fresh armies of locusts in the early autumn from the north and northwest, swept over the western border of the State. It should be noted that a great drought prevailed in the Northwest, which favored their multiplication as in other locust years, the drought and heat being the exciting cause of the undue increase of locusts and other insect pests.

"The middle western counties which suffered most in 1875 (*i. e.*, the portion of the State in which the winged insects reached the farthest east in 1874, and laid most eggs) were not overrun in 1876, and will not suffer in 1877. Such are the counties of Platte, Clay, Cass, Lafayette, Johnson, Henry, Pettis, Bates, and Benton. In these counties the farmers have little or nothing to fear, except as they may receive a few straggling and comparatively harmless bevies of the winged locusts next June and July, from the neighboring country. The counties that were overrun and will suffer are, first, Atchison and Holt, and the western half of Nodaway, and Andrew in the extreme northwest corner; second, McDonald, Barry, Jasper, Lawrence, Barton, Dade, Newton, Cedar, Vernon, more particularly in the southwest half; Polk, in the northwest third; Hickory in the southwest third; Saint Clair in scattering places, and Christian and Greene in the extreme border.

"The locusts came into all these counties last Fall, very generally ate off the Fall wheat, and filled the ground with their eggs, in most parts quite thickly. As elsewhere they continued laying until overtaken by frost.

"Bates, according to one correspondent, also received a few of the insects in the western half; while a few stragglers are also reported in Harrison, and even in Gentry, Henry, and Cass; but it is evident that in these cases they were not in sufficient numbers to do harm or to cause any forebodings in the spring. They came into the northwest corner from the north and northwest, early in September,[2] and were to some extent prevented from reaching beyond the points indicated, by south winds.

"They entered the southwest counties from the southwest nearly a month later, invading Newton and McDonald by September 23, and reaching the middle of Barry by the 1st of October, and Cedar by the middle of the month. It is quite clear that the eastern limit of the swarms which came from the north and northwest was receding west-

[2] According to Signal Service reports, some were seen in Nodaway County much earlier.

ward after they reached Northwest Missouri; and that Southwest Missouri, Southeast Kansas, and Northwest Arkansas, would have escaped had it not been for west and southwest winds that brought back insects which had reached south of these points.

"The dates of arrival of these insects are nearly a month later than in 1874, and in this respect the 1876 invasion more nearly resembles that of 1866. It was also less immediately disastrous than that of 1874, and most of the crops were either garnered or beyond injury, and the principal damage was to the Fall wheat, which, as already stated, was eaten down, and in most cases effectually destroyed, at a time, too, when it was generally too late to do anything more than to let the ground lie over to plant in corn in the spring."—(Riley's Ninth Report.)

1877.—Although the prospect of injury from young locusts was threatening, yet, as in Kansas and Nebraska, the young soon after hatching perished in large numbers, so that little injury was experienced and the crops were unusually large. No locusts arrived in the State from the Rocky Mountains. The swarms of fledged locusts which survived the cold, wet weather were light in the State, and did no mischief, and, so far as known, laid no eggs. The following statement will give some idea of the distribution and movements of the local swarms:

"The insects were leaving Jasper and adjacent southwest counties where they had hatched, the latter part of May and early in June, that part of the State being vacated by the middle of June, and the course being north and northwest. They left the northwest counties toward the end of June and during the first week of July, the direction being northwest, except on June 30, when some stragglers were blown back from the northwest over Nodaway County."

August 14, large numbers passed over Oregon, Holt County, flying southwest; about the 20th, a few passed over Flag Springs, Andrew County, from the northeast; at Pickering, Nodaway County, during the third week in September large swarms were observed flying from the northwest to the southeast, but none were known to alight. In Atchison County large swarms from the north passed over in August and September, and a few dropped down, but no eggs were deposited.

THE LOCUST IN KANSAS.

We have fuller information regarding the ravages of locusts in this State than in Nebraska, probably from the fact that the State was settled earlier and has a much larger population, and suffered more from the hordes of invading locusts.[3]

[3] 1846.—There are no records of locusts in Kansas in 1846, and I quote the following statement doubtful whether the grasshoppers referred to were local species or emigrants from the west. "As we proceeded on our journey, we heard the confused hum of thousands of grasshoppers, now and then broken by the chirping of the cricket. These insects are found in great abundance, and obtain greater size than any I have seen elsewhere."—(Notes of a Military Reconnaissance from Fort Leavenworth, in Missouri to San Diego, Cal., by W. H. Emory, p. 392. The insects were observed July 2, 1846, in the Kansas River Valley.)

1854.—Locusts visited Kansas, but how extensively is not known; the swarm arrived in the autumn.—(T. C. Wells.)

1855.—The eggs laid the previous autumn hatched in the spring of 1855, "and if I remember aright one of our old farmers who was then living on the south side of the Kansas River told me that his wheat was all destroyed by them. I do not remember seeing any myself that year. It was dry in the spring, but after about the middle of May we had frequent and very heavy showers all through the season."—(T. C. Wells.)

1856–'57.—"In the autumns of 1856 and 1857 the wheat and corn leaves were eaten off around the outside of fields, I suppose by *Caloptenus spretus*, though I never noticed them in great numbers so as to attract particular attention until 1860."—(T. C. Wells.)

1860.—That locusts appeared in Kansas this year is affirmed by Mr. T. C. Wells, who remarks, "What I have said about them in 1860, and from then to the present time, I *know* to be true from my personal observation, with the single exception of 1864."—(T. C. Wells, Manhattan, Kansas.)

1864.—"I was East that [this] year, but am told by those that were here that it was very dry, and that the locusts were here."—(T. C. Wells.)

1866.—The first record of any invasion we are aware of refers to this year, though it is not improbable that a portion of the State, at least, was overrun in 1820 or 1821, and, possibly, in 1846, but there are no records to that effect extant.

In August and September, 1–10, 1866, swarms of locusts arrived. In August they made their appearance in the frontier settlements of Kansas and Nebraska, and later, early in September, destroyed every green thing in tracts in the eastern part of the State. On the Nemaha River (which, however, lies mostly in Nebraska) and is in the eastern limits of the State, they arrived in clouds "glittering in the sunlight like huge flakes of snow," and destroyed the late corn and the winter wheat, and began at once laying their eggs, so that the ground was fairly honeycombed by their egg-cells.

September 1. At Council Grove "a tremendous shower of grass-hoppers came from the south, completely filling the air as high as one could see, and looking like a driving snow-storm"; they eat every green thing. In Allen County they appeared September 11; "they almost darken the sun in their flight"; they eat everything green, including winter wheat. "In Brown County they covered a tract twelve miles in width, and consumed pretty much everything green. Trees were stripped of their leaves, and corn-fields literally stripped to the stalk. * * * In Northwestern Kansas they filled the air so as to obscure the sun. They have been traced for a distance of two hundred miles above Fort Kearney. In Marysville the grasshoppers in that section eat every green thing. The Leavenworth papers reported that a vast army of grasshoppers reached Lawrence from the west. They had cleaned out Topeka,

the capital, of garden vegetables, grass, and clover, and left the ground as if burned with fire. Corn is eaten to the roots. About Lawrence, though very numerous, yet coming so late they did not do essential damage, but deposited their eggs. In Douglas County they made their appearance by the billion. The prevailing winds in the State during August and September were westerly, and the season was dry and hot.—(*Practical Entomologist*, ii, 3–4.)

1867.—The locusts this year, according to B. D. Walsh, "took a rather more northerly course, the main body descending through Nebraska upon Iowa, instead of through Kansas upon Missouri. Still in both years there were flying columns of the enemy, that deviated a little from the general line of march either to the right or to the left. For, as will be seen hereafter, some of the more northerly parts of Kansas and the extreme northwest corner of Missouri were invaded by the army of 1867; and as I have shown in the Practical Entomologist, the southern parts of Nebraska were very generally invaded by the army of 1866." Nearly as last year, the invasions occurred from August 25 to September 30, and the locusts came from the northwest.—(Walsh's First Illinois Rep.)

1868.—Locusts, which hatched in the spring, devastated the State, locally, and the region west of Fort Riley was ravaged in the autumn, but whether by foreign swarms or those native to the State is not stated. August 7, locusts appeared in Riley County, flying from the northwest apparently, as a southeast wind prevented their leaving on the 8th. It is possible that the swarms came from Iowa and Minnesota, rather than from the west. In the early part of August they attracted attention in Kansas and during the preceding month in Iowa and Minnesota. (American Entomologist, i, 74.) From this fact we infer that the invasions were local and from the north.

1869.—For two years, apparently, the progeny of those which overrun the State in 1866–'67 remained and did some damage. In 1869 the young hatched out in Saline, Lyon, and Brown Counties, but left as soon as they acquired wings, namely, about the middle of June. They were destructive east of Nemaha County, but no extended damage was done in the State generally, and none were seen in 1870 and 1871.

1872.—This year "foreign" locusts did some harm in parts of Kansas. At Beloit they appeared in the last week in August and devoured everything green.—(Riley's Seventh Report.)

1873.—While Nebraska and the country to the north was generally overrun in 1873, there is no record of their appearance in Kansas.

1874.—This was the worst locust year in Kansas, the State, like its neighbors north and south, suffering extremely. Mr. Riley in his seventh report says the locusts swept over the State "in overwhelming hordes from the plains of Colorado on the west, and the fields of Nebraska on the north, in many instances clearing off all traces of vegetation in a few hours." The corn crop was ruined by them. They appeared in every county, so far as the records show, except Clarke, Comanche,

Gove, Doniphan, Graham, Greenwood, Harper, Hodgeman, Kiowa, Neosho, Ness, Pratt, Sumner, Stafford, Trego, and Wallace, which are more or less unorganized and uninhabited, so that no records were obtained, though they were overrun like the rest according to Mr. A. Gray, secretary of the Board of Agriculture. The suffering was great, thirty counties reporting 1,842 families, aggregating 9,154 persons, reduced to destitution, and immigration to the State was checked, and relief societies throughout the country were formed to aid them.

About the 15th–25th of July, the locusts appeared in Northern and Northwestern Kansas, and continued to be destructive till at least the end of August, and laid their eggs in the autumn. During this year the greatest damage was from northwest to southeast, being lightest along the eastern half of the State, which the winged insects reached too late to do very serious injury; but the greatest bulk of the eggs were laid as the locusts approached the eastern limits of the State.—(Riley's Eighth Report.)

1875.—In this year the damage done was by the young locusts, which hatched in enormous numbers in the eastern part of the State, so that, as Mr. Riley states, "in 1875 the tables were turned; the eastern portion of the State suffered, and the western counties were little troubled." He also states that "the ravages of the young locusts were confined to a district of about 150 miles in length and 50 miles in breadth, at the widest, along the eastern border. The counties of Doniphan, Brown, Atchison, Jefferson, Leavenworth, Douglass, Labette, Johnson, Miami, Franklin, Linn, Bates, and Bourbon, suffered more or less severely." The locusts hatched out mostly in April and early May, and became fledged May 28 to June 15, and then all flew in a general northwest direction. (Riley's eighth report.) The writer passed over the ravaged region along the Kansas Pacific Railroad just after the locusts had taken flight and witnessed the bare fields, desolated towns and general ruin they left behind along this part of the country. They flew out of the State, and there were no invasions from the north or west that year, and no damage done after the middle of July. Still, owing to the fear of disaster, there was said to be a heavy emigration of farmers from the State.

1876.—There were fresh invasions from the north and northwest from late in July until early in September. "Early in September the swarms thickened, and the wind blowing almost a gale from the west and northwest for two or three days subsequently, the insects during that time swept down in darkening clouds over the greater portion of the State from the 98th meridian to beyond the 96th. (Riley's ninth report.) Prof. F. H. Snow, October 4, 1876, made the following statement:

I came through Kansas from Colorado (Denver) on the 5th and 6th September. *Caloptenus spretus* at that time extended about 100 miles east of the mountains, last of which point no trace of it was to be seen during the daylight on the 5th. Next morning we struck locusts in small numbers at Brookville (Saline County), 180 miles west of Kansas City; in full force at Salina, 12 miles farther east; and found the east front of this

line 4 miles west of Abilene, in Dickinson County, and about 150 miles west of Kansas City. Observing and inquiring at the stations in this 30-mile belt, I invariably learned that the flight of the locust was from the *north* and not from the *west*, as two years ago (in 1874).

Four weeks have now passed and the locust has not yet reached Lawrence, its eastern line being about 20 miles west of Lawrence, only about 100 miles farther east than it was four weeks ago. This eastern line extends across the State from north to south, the entire State west of this line having been visited. In many places the pest has come in immense numbers, while in many other places there has been but a light sprinkling. Little damage has been done thus far, almost none at all in comparison with two years ago, it being so late in the season that the crops of this year were secure. The fall-wheat, however, has been very generally eaten down, but has come up again when *drilled* after the departure of the hordes which remain but a few days in a place. Wheat sown broadcast has been generally killed, having been eaten down to the kernel. The great danger to be feared now is the spring-hatching of the eggs which have been deposited in varying abundance in the eastern part of the region visited. It is agreed on all hands that the present visitation is far less numerous than two years ago. The locusts are everywhere reported to be heavily parasitized by the red mite and the Tachina fly. Can it be that these hordes are the "spring hatch" from Iowa, Minnesota, and Wyoming? While in the South Park in July, I found great numbers of young *spretus* along the streams from the mountain-sides. When on the summit of Pike's Peak, July 28 and 29, the winged results were flying due east as high up in the air as the eye could reach. They did not descend upon us at Manitou until the 12th of August. (Packard's report in Hayden's Survey, 1875.)

At Abilene locusts were observed August 24 and 25 going in a southwest course, with the wind moderate from the northeast. "September 2, 3, and 4 vast swarms flew north; September 6 vast swarms going northwest, the wind strong from the southeast. September 7, at about 11 o'clock, the advance guard reached Abilene going due east, with a strong gale, flying very low. They began falling at once, and kept gradually changing their course until 1 p. m., when they went due north and ceased flying at 2 p. m. The ground was alive with them, and some of the citizens smoked them out of their gardens successfully. A thunder-storm reached us at 6 p. m., and the rain fell in torrents until midnight. September 8 the locusts seemed more active after the previous night's flood than was expected, as we supposed that they were all drowned in the torrents of water that fell, and by 11 a. m. the air was full of locusts flying so low that clouds of them could be seen at a great distance in every direction. I have not seen such quantities in six years' observation. On the 9th and 10th, after a rainy night, the locusts in innumerable quantities left in a very strong cold north wind. Afterward a few flew northward and westward, but the bulk passed to the southward, and no flights were observed after the 26th, when the direction was due south."—(W. T. Davidson.)

Mr. Gaumer states that the invading swarms in the autumn deposited their eggs in almost every available place throughout all the counties of southeastern Kansas.

1877.—Although much trouble was expected from the young locusts this year, yet owing to the exceptionally wet and cold spring and early summer, the young died soon after hatching, and did little local injury.

No invasions from the Rocky Mountains occurred, and only local swarms after July 8 passed to and fro over the State, laying few or no eggs, and whatever apprehensions were felt in the early spring the result shows that an unusually large wheat-crop was raised.

To enter a little more in detail: Throughout the locust area of the State south of the Kansas Pacific Railroad—which area includes most of the region bounded on the east by a line running from a little west of Lawrence toward Fort Scott, and on the west by another passing up through Hutchinson and Ellsworth—the eggs were laid in 1876 in sufficient quantities to have given birth to locusts enough to have eaten everything green by the time they attained full growth, under conditions favorable to them. Many of the eggs were destroyed by the Anthomyia egg-parasite, and the other enemies described in Mr. Riley's Reports. Some of them hatched in the fall, and many more during the warm weather of the latter part of January and fore part of February. The insects thus hatched perished. The bulk of the eggs hatched during the last week of March and the early part of April. The young insects were very thick then; they commenced to do injury and begat general fear. The farmers for the most part fought them with energy. Then followed, from the middle of April on, a period of cold and wet weather; the young rapidly weakened and were from all quarters reported as disappearing. The continued cold after the principal hatching, had the effect to kill many that were just hatching or moulting. The heavy rains also washed many away into the streams, and in some instances on soils which contain sand and lime, and which are liable to crack when dry, the rains doubtless covered up and killed such as were sheltering in such fissures.

Still, considerable numbers became fledged, and local swarms were passing through and over the State, through the summer; while light swarms flew into the State from the south and north. For example:

A small swarm passed over the western part of the State May 17 and 19, in a north and northeast direction. Other flights, all going northwest, passed over Labette County May 23, and over Norton and Ellis Counties in the same direction from the 21st to the 23d. An extensive swarm passed over the western counties May 26 and 27, flying north. Light swarms passed northwest at intervals from this time on until the main exodus from the State. This occurred on June 12, 13, and 14, and was very general, the insects flying due north.

From the 15th to the 20th, the locusts were leaving in scattered numbers whenever favorable weather prompted, and after the 20th few remained, save in exceptional localities where hatching was greatly delayed from local causes.

After this date the following observations were made by Mr. Gaumer, at Lawrence:

At 1 p. m. June 16, the first winged locusts were seen flying over the Wakarusa. They were very high in the air. The wind at the time was blowing at the rate of about fifteen miles per hour, from a direction a little east of south, and the locusts were flying with the wind. The sky was nearly clear and weather warm.

June 18, they again began to fly, at 11.45 a. m. The wind was south-southwest, and blowing at the rate of about forty miles per hour. They increased in number until

2.35 p. m., when there were a great many flying, as high as could be seen with the naked eye. At 3.30 many of them were quite low, and a few were seen to drop down, and they continued to fall until 4.30 p. m. At 5 p. m. they ceased to fly, and there was about one locust to every square rod. They flew very swiftly, and in a north northeast direction.

June 19, I again visited the country round about Chanute. Found the locusts had nearly all disappeared. Those which had hatched previous to my first visit had all died in a few days afterward. The eggs were not all hatched, for in front of Mr. Ashby's house we dug up good eggs which had been deposited in a hard, sandy soil, and were overlaid with a deposit of sand about one inch deep, from an adjoining field. Most of them were spoiled.

At Parsons, June 20, I found the locusts molting the last time, and many of them already had their wings. Some were flying, but not in any considerable numbers. Few had come to maturity. At Chetopa they nearly all had wings, and had been leaving for two days. Several large swarms were seen feeding upon dog-fennel, but nowhere did they injure the corn or wheat. Nearly all the gardens in the eastern portion of the city were eaten up.

Locusts were observed flying over Lawrence in a northerly and northwesterly direction, every clear day, until July 10.

The heaviest flight of the season was southward on the 20th of July. Light swarms continued to fly about in various portions of the State until October, flying southward and southwesterly.

THE LOCUST IN NEBRASKA.

While only the western half of Minnesota and the western third of Iowa are liable to invasion, the entire State of Nebraska has been more or less invaded, different portions, however, suffering in different years.

1857.—There must have been a locust invasion in this year in Western Nebraska, for the young appeared in 1858 as may be seen by reading the subjoined paragraph.

1858.—"In the spring of 1858, as soon as grass was three inches high, near the creek and through the valleys, we found them. * * * They ate my corn which was four or five inches high, also turnips, grass, &c., (and I believe onions) but their ravages were not great. * * * I heard that they were bad on the Missouri River that season, 400 miles northeast of Laramie, the direction the wind took them. And the next season I heard of them in Minnesota." (W. M. Hinman.)

1861.—"Also yesterday, at 12 o'clock, I discovered them very thick and high up, traveling with the wind to the northwest for one and a half hours, when there were no more to be seen. We have had two or three days of hard southeast wind, and probably these were successive grasshoppers from Texas or the Cherokee country." (W. M. Hinman in a letter to the Smithsonian Institution, dated June 10, 1861).

1864.—This is the first year, as yet known, in which Nebraska suffered. According to Governor Furnas, Northern Nebraska was overrun by locusts this year.

1866.—Late in August swarms crossed the State (especially the southern half) from the west, extending nearly or quite to the Missouri River, devouring everything about Fort Kearney, and Nebraska City, and the

other frontier settlements. That the invasion was widespread is evidenced by the widespread abundance of the young the following spring.

1867.—This was also a notable locust year, the whole State being more or less afflicted, the young being abundant and destructive in the spring, and in the summer fresh swarms coming from the northwest. From Walsh's First Illinois Report, we learn that in May, about Omaha, the young hatched out by the million, from eggs which were "deposited over the whole face of the country, from the lower part of Cass County, clear through the southern part of Kansas." Early in June a storm in the country south of the Platte, rid that region of the young, the work of destruction having been farther carried on by black birds, plover and other birds. Late in August, and in the autumn, there were heavy invasions from the northwest in the Missouri Valley.

1868.—The young hatched from eggs laid in the previous summer; hatched out in large numbers all over the State, many hatched late in May, but throughout the spring millions were killed by heavy rains and some few by birds. (Bruner). Nevertheless, extensive damage was done by them.

1869.—Although there are no records at hand regarding locust invasions this year, yet as the insects occurred in abundance in Iowa and Kansas, they must have been more or less destructive in Nebraska.

1873.—After an interval of four years, swarms of locusts appear from the west and northwest and overrun Nebraska as well as the adjoining States. In Adams County a considerable flight of locusts passed northwardly May 19th or 20th, remained till the 25th or 26th, when they rose and flew north, doing but little injury. In the autumn a number of swarms passed southward, but did slight mischief.

1874.—This was the most calamitous locust year in Nebraska, as well as throughout the West, beyond the 94th meridian. Not only did the young locusts hatch in great numbers, but also swarms of unusual extent swept over the State and proved more destructive than at any year previous or succeeding. It is to be observed that this was an exceptionally dry and hot summer, locusts always abounding in dry springs and summers. The entire State from a point about thirty miles from the Missouri River, west, was more or less devastated, the extreme western portion entirely so. (Governor Furnas). Swarms arrived on or about July 21, remaining about ten days, time enough for them to devour the corn crop and deposit their eggs by the million.

1875.—The locusts hatched remarkably late (about May 20th from eggs laid in the previous summer, principally in the district immediately bordering on the Missouri River, and a comparatively small area suffered from the attacks of the young. "The populous and highly cultivated counties of Nemaha, Richardson, and Otoe were most severely ravaged. Before these locusts acquired their wings, swarms from the south in a northward direction over the State, cause some trouble and anxiety in the following counties: Saunders, Washington, Douglas, Buffalo, Pawnee,

Clay, and Barton. The loss, however, to the State at large did not amount to five per cent." (Riley's eighth report.)

1876.—Another invasion of the State in August of this year, resulted in the northeast counties in the loss of one-half of the corn crop, while the western half of the State, particularly in the valleys of the Elkhorn, Platte, and Republican Rivers, suffered a good deal. Eggs were laid over the eastern part of the State, but less extensively in the western portion. (Riley's ninth report). By some good observers, the invasion of 1876 was considered as calamitous as that of 1874, and it is to be noted that the summer of 1876 was extremely hot and dry, the prevailing winds south and hot, much as in 1874. The year ended with bad prospects for 1877, the ground all over the State being well seeded with locust-eggs.

1877.—The early and late spring and early summer being unusually wet and cold, multitudes of the young locusts were killed, lying upon the surface of the ground so thick that they could in places be picked up in handfuls. Happily, owing to these favorable meteorological causes so unlike those of the previous year and 1874, the amount of damage done was comparatively slight and an unusually large wheat and corn crop was raised raised in this State as well as throughout the Mississippi Valley States. Owing to the same cause in the northwest, and the fact that few eggs were laid in the larger portions of Montana, Dakota, and Wyoming, as well as in British America, there was no invasion of locusts late in the summer, from the Rocky Mountain region, leaving excellent prospects for an immunity from their attacks in 1878. Light swarms moved into or across the State from the south in June, and local swarms were observed in August.

The following statements received from our correspondents will give an idea of these local flights:

A small flight passed over Franklin County, as early as May 17, flying northwest, and another over Butler County, May 19, flying north. A heavy swarm passed over Agallala and adjacent counties, during May 26, 27, and 28, the direction being northwest. They were seen sparsely flying in the same direction on various occasions until the middle of June, when extensive flights were again reported, especially over Butler and Platte counties. During the latter part of June and first part of July the insects were rising and leaving every day when the weather was favorable, or the wind from the south or southeast.

On and after August 6, they began at Geneva, Platte County, to "go south and southwest in swarms, which continued daily, whenever the wind was favorable, for over a month. *They showed no disposition to alight*, except when compelled to do so by opposing winds." At Salem, "fresh swarms were seen to pass over this point on the 8th and 9th of August, and light swarms continued to fly as late as the 25th of August." At Steele, Jefferson County, from the 13th to the 23d of September a good many locusts passed over, mostly from the northeast. At Pleasant Hill, Saline County, "large swarms passed over from the northeast, undoubtedly from Northwestern Iowa, Southern Minnesota, and South-

eastern Dakota, and settled in places here. They avoided cornfields, settling in small grain and grass. They appeared to be in a feeble, degenerate condition, always leaving the next morning, eating nothing, appearing to come down to rest. They departed in a southwesterly direction." At Nebo, "after our own crop left, swarms were flying over us for many days from the northeast." At Dewitt, Saline County, "fresh swarms from the northeast passed over, and some few settled, but went off again in a few days, except a few stragglers that remained until October 1; no eggs were laid." At Omaha swarms were observed in the air.

THE LOCUST IN IOWA.

This State has probably been afflicted in nearly the same years as Minnesota; the locusts never extending, however, more than a little beyond the western half of the State.

1833.—The authority for a locust invasion this year is the following extract from a letter from Mr. A. Strong, of Pocahontas, Iowa, to Mr. Whitman: "In regard to the grasshopper raid of 1833, there was no white settlement here then, but there is a part of a tribe of Indians living near the center of this State, and they used to hunt through here, and in some of their visits here in 1866, their chief, Johnny Green, who was a very old man, told the people here that thirty-three years before that the grasshoppers came so thick that the grass was all eaten off, and there was no grass for their ponies; and the ground looked black, as if there had been a prairie fire. He also said that there had been no more grasshoppers till 1866, when he was speaking. This chief was a very intelligent man, and was about one-half white; but the Indians are very liable to exaggerate; I have forgotten the name of the tribe of Indians, but think they were the Winnebagoes or Pottawattomies."[4]

1856.—In Western and Northwestern Iowa, their ravages this year were inconsiderable (Riley's seventh report). They came in August from the north and flew south. Eggs hatched in great numbers in the spring, but no damage was done by the young in 1857. (A. H. Gleason, Little Sioux, Harrison County.)

1857.—The general locust invasion which swept this year over the Northwest, also reached as far east as Central Iowa. (Riley's seventh report.) Ida, Adams, Pottawattamie (Council Bluffs) Counties were visited. (Whitman.)

1864–'65.—Some damage was done in 1864 about Sioux City. Eggs were laid which hatched out in 1865; the young doing considerable mischief.

1865.—The Saint Paul Press for June 21, 1865, is authority for the following statement: "General Sully, in a private letter from Sioux City, gives the following account of the grasshopper plague which is

[4] Col. W. Thompson, of Bismarck, told us th at in 1850, at Council Bluffs, grasshoppers ate up a cornfield late in July or early in August; the corn belonged to the Mormons. The species may have been, and probably was, *Caloptenus femur-rubrum*, the common red-legged locust.

desolating the region of country he has traversed. He says: 'The only thing spoken of about here is the grasshoppers. They are awful; they have actually eaten holes in my wagon-covers, and in the 'paulins that cover my stores. A soldier on his way here lay down to sleep in the middle of the day on the prairie. The troops had been marching all night. His comrades noticed him covered with grasshoppers, and woke him. His throat and wrist were bleeding from the bite of these insects. This is no fiction.'"

1866.—"In regard to the raids here, the one in 1866 did not extend but about fifteen miles east and fifteen miles south of here, while the next raid went a little farther east and south; till the last one went over a large part of the northwest portion of Iowa." (A. Strong.)

1867.—Young, unfledged locusts made sad ravages upon the crops of Southwestern Iowa. Later in the season there was a general invasion of the State, the swarms arriving at Fort Dodge September 10, in Clark County about October 5. "So far as we have been able to learn they did not appear beyond the eastern boundaries of Polk and Marion Counties in 1867." (Iowa Homestead.) "Grasshoppers came here from the southwest on the 10th September, 1867, and deposited eggs shortly afterward. The young hatched in the May and June following, taking the garden vegetables as fast as they could find them; oats and wheat also suffered severely."[5] "A swarm of grasshoppers swept from Fort Benton to Missouri, reaching as far east as the Des Moines River. I have read of them as being at Denver, Colo., at the western terminus of the Kansas branch of the Pacific Railroad."[6] Mr. Whitman writes us that upon inquiry he finds "that the visit of 1867 was very extensive in that State" (Iowa). He adds that Ida, Carroll, Greene, Sac, Webster, Adams, Guthrie, Pocahontas, Orange, Woodbury, Pottawattamie, Page, Hamilton, Calhoun, Adair, Audubon, and Plymouth Counties were visited this year.

1868.—Locusts visited Page County August 7 and 8 in "fearful numbers"; they also visited Boone, Buena Vista, Woodbury.

1870–'72.—"In 1870 Algona was visited, and in 1871 the progeny hatched by myriads till after the 1st of June, and left about the 1st of July." (Riley's seventh report.) "In the seasons of 1871 and 1872 they flew over, but few alighted; no damage was done." (H. J. Newell, Athol, Sioux County.)

1873.—The northwestern counties of Iowa were swept by swarms of locusts. (Riley). Harrison County was visited and some destruction done; they deposited eggs, which hatched out April and May of the next year. Athol, Sioux County, was visited by a heavy swarm from the south in June, which did much damage; the insects deposited eggs. (H. J. Newell.)

1874.—Much of the injury done in Iowa this year resulted from the

[5] Oscar J. Strong, Rolfe, Pocahontas County, Iowa, in Western Farmer, February, 1869.

[6] S. Morrill, Onawa, Iowa. (Iowa Homestead, November, 1867.)

attacks of the progeny of the 1873 swarms. Fresh swarms came, however, in 1874, and the western counties of Algona, Calhoun, Cherokee, Clay, Dickinson, Emmett, Harrison, Humboldt, Jasper, Kossuth, Lyon, O'Brien, Osceola, Palo Alto, Pocahontas, Plymouth, Sioux, Winnebago, and Woodbury, suffered more or less. As the drought was less severe than in other parts of the country, and the crops good, the distress in the ravaged counties was easily relieved. (Riley's seventh report).

"In 1874 the young 'hoppers destroyed gardens and injured other crops. Heavy swarms also came from the north in the latter part of July or the first of August, doing great damage." (A. J. Newell, Athol.)

1875.—Few locusts hatched in the spring of this year in Iowa, but about the 10th of June until the middle of July, swarms flew in from the south over the western counties, "many of which alighted and remained one or two days, committing depredations in corn-fields, gardens, and nurseries. Rye, wheat, and oats were also damaged to some extent. From the counties of Mills, Fremont, and Council Bluffs a loss of twenty-five per cent. was reported. (Riley's eighth report.) At Athol Mr. Newell reports that "a swarm passed over from the north; a few alighted; but no damage was done to speak of."

1876.—As in a few of the southwest counties in Minnesota, so in adjoining parts of Northwest Iowa, and notably in Osceola and Dickinson Counties, the young insects hatched out from eggs laid in 1875, but by the middle of June they had disappeared without doing much harm, or, in some cases, moved off in a northwest direction. About the 1st of August, the northwestern counties of this State were visited by heavy swarms. "They appeared to cross the State line from Dakota and Minnesota at almost exactly the same date for Emmett, Dickinson, Osceola, Lyon, Sioux, and Plymouth Counties, and from here they swept at once out into the counties lying eastward and a little to the south." The most eastern point reached was in the middle of the State, and the line retreats westward from Story County both north and south. (Riley's ninth report.) "In summing up their coming here, I will say that from the year 1856 there has not been a year but that swarms have been seen passing over from the northeast, north, and northwest, but, with the exceptions of the years when they were exceptionally abundant (1856, 1867, 1874, and 1876), they have never deposited their eggs to any great amount." (Whitman.) They laid eggs at Ames. (Bessey.)

1877.—In the spring of this year the young hatched out in the following counties: Lyon, Ida, Carroll, Greene, Sac, Hancock, Webster, Madison, Guthrie, Wright, Pocahontas, Boone, Buena Vista, Winnebago, Sioux, Woodbury, Pottawattamie, Page, Hamilton, Worth, Calhoun, Adair, and Plymouth, but the cold wet weather killed them, and little destruction was done except in Pottawattamie County. (Letter from Mr. Whitman.) There were no invasions this year from the northwest.

The first return flight reported over this State was on June 14. It was dense and toward the north. The next day the wind was pretty

strong from the north, and the locusts were checked and ceased to fly; but on the two following days, the wind blowing from the south again, they continued to pass over. From this time on till the first week in August they were leaving the State, the direction being uniformly northwest. As soon as they became winged, myriads flew over Webster City, apparently going southward. At Athol, Sioux County, our correspondent reports that "after the departure of the young locusts, swarms from the north-northeast and northwest passed over July 15, 16, 20, 27, 28, and 31, August 1, 6, 7, 8, 9, 21, and 22." At Council Bluffs "fresh swarms passed over from the north, but did no damage and laid no eggs." At Des Moines, "fresh swarms came from the north and northwest in August, but did little damage." Locusts passed over Sac City in great numbers during August, going south-southeast and southwest, but none alighted. (Whitman.)

THE LOCUST IN MINNESOTA.[7]

Besides those years in which the region now comprised within the State of Minnesota has been scourged in common with other States and Territories, there are various statements, allusions, and traditions to be collected, which go to show that the Northwest has been repeatedly visited by the locust in years previous or additional to those in which such occurrences have been historically recorded. Some of these traditions are probably of no value, whatever their intrinsic probability may be. Among these are the traditions, said to be derived from the Indians, that the locusts had formerly taken possession of the country and held it for seventeen years; also that they had, in times past, consumed the vegetation as far east as Stillwater (though this may perhaps refer to the year 1856). Setting all these aside, the statement made by Capt. Jonathan Carver (in his "Narrative" of the year 1766), that large swarms of locusts "infest these parts and the interior colonies and oftentimes do much mischief," shows that such occurrences were *repeated*. It is difficult to say what regions are denoted by "these parts"; but his usual application of the word "interior" is to the regions from the great lakes westward.

The visitations of locusts in Lord Selkirk's Red River colony in 1818 can hardly be said to concern Minnesota, as but a small portion of that colony lay within what are now the borders of Minnesota; but it is not improbable that the wilderness to the northwest was overrun in those years.

1830 and 1842.—Still further allusions may be found in the following extract from a letter of Rev. J. A. Gilfillan, missionary at the White Earth Indian agency, to the Minnesota grasshopper commission, 1875:

"My informant, Michel Villebrun (a Missouri River half-breed, residing at the agency, now seventy years old, whom I consider a reliable

[7] Prepared for the Commission by Mr. Allen Whitman, Assistant to the Commission.

man), went to Fort Garry forty-five years ago (1830), and saw there for the first time quantities of grasshoppers. They thickly covered both sides of the river for some distance back, and the river was covered with dead ones. Twelve years after the above-mentioned date (in 1842) he came down from Fort Garry to Saint Paul; there were then none at Fort Garry and but few at Saint Paul, but the prairies between these two points were full of them. He came by the way of the Minnesota River."

Still another reference is found in a letter to the New York Tribune, dated June 9, 1857, from Medicine Lodge, Hennepin County, Minnesota, and signed "J. H. H." "About six years ago, as I am informed by a Frenchman who lived at Red River at that time, they (the grasshoppers) destroyed the crops so that the infant colony did not save their seed, but were obliged to live by hunting and fishing."

1849.—Such statements as these it is, of course, no longer possible to verify, but that there is nothing intrinsically impossible, or even improbable, about them may be seen from the following letter from Mr. J. W. Burdick, of Willmar, Minn., an old resident in the Northwest, since 1856. As his letter refers to localities and dates about which it is now difficult to collect or recall facts, I quote it nearly in full, giving the different portions of it under the years to which they refer.

WILLMAR, MINN., *September* 29, 1877.

ALLEN WHITMAN, Esq., *Saint Paul, Minn.:*

Yours of September 25 is at hand. In reply I would say that I have no personal knowledge of the grasshoppers visiting Minnesota prior to A. D. 1856; but was informed by Indian traders and frontiersmen that they had made their appearance in vast numbers along the prairie regions west of the big woods about A. D. 1849, and, as far back as any trace could be made, always making their appearance in seasons of great drought; but as there were no cultivated lands previous to 1856 in all this vast region, their depredations were confined to the natural herbage of the country.

The year 1855 is sometimes included among the locust years of the State of Minnesota. I know of no other authority[8] for it than the statement on page 203 of the Annual Report of the Board of Regents of the Smithsonian Institution, 1858. "Every Western man remembers the visitation of grasshoppers in 1855 and 1856 in Kansas, Nebraska, and Minnesota Territories which caused such injuries to the crops of the Indians." But the press of the State for that year (1855), so far as I have been able to learn, contains no allusion whatever to grasshoppers, except in California and Utah. If there were any locust invasions in Minnesota, all the State papers to which I have been able to have access have totally failed to record it.

In 1856-'57.—On the other hand, the State press for the summer and autumn of 1856 is full of notices of invading swarms of locusts, while numerous letters and replies to the circulars of the entomological commission confirm the fact that it was not till 1856 that the invaders reached at least the cultivated portions of the State, and principally the region lying along the Upper Mississippi.

[8] We may add that Col. G. W. Sweet stated to us in Bismarck that locusts arrived at harvest time in Saint Cloud, Minnesota, in 1855. They hatched out in 1856.

They reached the Chippewa Agency at Gull Lake (now in the southern part of Cass County) on the 27th of July, and had arrived at Otter Tail Lake (Otter Tail County) several days before. Their arrival at Sauk Rapids (Benton County) is noted in a letter to the Saint Paul Weekly Minnesotian, and dated August 23, 1856. They reached Monticello (Wright County) on the 13–16 of August, and the western part of Hennepin County in the same month. In the latter part of the month they reached Carver County, and still later in the season extended to Saint Anthony and nearly to Saint Paul. In the following spring the young were also found at Shakopee, Scott County, in parts of McLeod County, and along the Upper Minnesota River, and of course all these points also must have been visited in 1856. It is highly probable that the whole region west of the big woods was swept over in 1856. The letter of Mr. Burdick, referred to above, goes on to say:

"In 1856 they deposited their eggs in all the high, sandy hills, and in what prairie was broken by the settlers, along the Crow and Minnesota Rivers, which, owing to a very late spring in 1857, did not hatch until the month of June, when the excessive rains seemed to destroy all the local hatch; but about the middle of July of that year swarms came from the west and swept everything in the shape of grain and vegetables west of the big woods, and then disappeared just as they have now, no one knows whither." This fact of the arrival of swarms from the west and northwest is different from what occurred in the more easterly portion of the locust region.

Resulting swarms of 1857.—The records of the hatching swarms of 1857 are still more numerous. The hatching is reported from about the end of May onward, and the young insects were found to be numerous in the Upper Mississippi Valley and about Shakopee. Their vicinity to Saint Paul is noted in the Saint Paul Advertiser (of July 4), where they are reported on farms near Lake Como, "thick in spots and making their mark on vegetation." In June, the Shakopee Advocate says: "The recent cool, wet weather has been a serious check upon the grasshoppers. It is said that bushels of dead grasshoppers may be seen in masses on the prairies." The Saint Paul Advertiser of July 4 states: "It is only in the eastern part of the Northern Mississippi Valley, in Benton and Sherburne Counties, that they manifest a settled determination to clear out every green thing—where they appear in such masses as to crackle beneath the feet of persons walking over the prairies."

Toward the middle of July the notices of migrations begin, apparently somewhat later than in later years.

July 17, the Saint Paul Daily Pioneer and Democrat quotes the Monticello Times in regard to migrations to the south and southeast. August 1, the Sauk Rapids Frontiersman states that they have nearly all left that vicinity. "For several days of last week and on Sunday they were high in the air, like a snow-storm. They went south and southeast; did not deposit their eggs here."

Late in July, 1856, invading swarms came from the northwest into the Upper Mississippi Valley, and gradually spread along the river during the season, much the same as they had done in the past summer, and reaching nearly the same limits. The injury was, of course, felt most severely along the Mississippi and the cultivated region adjacent, but the locusts are said to have appeared along the Minnesota River, in the Yellow Medicine country, and at various points in the northwestern part of the State. It is probable that the northwestern part of the State was swept over by migrating swarms during the summer, much the same as in the present year. But few traces of these were seen the following year, except along the Upper Mississippi, where the damage was even greater than the year before. A general flight took place in July, and the direction of the departure was to the south and southwest generally, and was, perhaps, the occasion of the injury done in Iowa that year.

The southward movements of the departing swarms may be inferred from the following statement in the Saint Paul Advertiser, August 1: "The last number of the Faribault Herald announces their arrival in that section in swarms. They arrived last week and pounced upon every green thing, threatening destruction to ripening crops." The Saint Peter Free Press says of the grasshoppers: "This pest has arrived at last, and, we are sorry to add, is really doing much harm. From all accounts they are much worse back in the country than here. * * * We are glad to state, however, that they appear to be leaving, passing to the east and southward."

At Mankato the grasshoppers made their appearance in considerable numbers, but did not do any very serious injury.

Mr. Joseph Flanders, now of Mandelia, relates arriving at the Winnebago Agency, about twelve miles from Mankato, on the 9th of August, 1857, and meeting grasshoppers, "moving southeasterly, and many of them flying so low that it was with great difficulty we could continue our journey."

I ought to have included above the resemblances of the spring of the years 1856–'57 to that of 1876–'77.

1856.—The Saint Paul Weekly Times of July 12, 1856, says: "We regret to learn that the crops are suffering for want of rain, particularly oats and wheat. The shower yesterday will benefit them, but much more rain is needed to prevent a meager harvest." August 2, 1856: "The oat crop, owing to the June drought, will not yield as plentiful as in former seasons, although a very fair crop may be expected." Mr. M. M. Kellogg, of Saint Paul, who has kept a record of the weather for many years, writes: "From 1837 to 1862, a period of twenty-five years, there was but one drought in Minnesota, and that was in 1856. The drought in this year was not seriously felt, for the little rain that fell was tolerably well distributed through the summer months, and indeed the drought seems to have been local and to a considerable extent limited in its range."

The letter of J. W. Burdick describes the character of the spring in 1857. Also, the letter of J. H. H., above referred to, says: "One of my neighbors, who by the way is a pious Catholic, says that the Almighty has tried all the usual means of destruction this spring without effect, viz, cold, backward and wet spring, late and severe frosts, and frequent thunder showers."

1863–'77.—No extensive depredations by the locusts in Minnesota are heard of between 1857 and 1864. It has been common to name the years 1864 and 1865 as the only "locust years" between 1857 and 1873. It will perhaps surprise some of our own residents to learn that from 1863 to 1877 there has been hardly a year in which the locusts have not made themselves noticeable within our borders, but principally in the Red River Valley when not heard of elsewhere. In 1866 there was a slight visitation in Kundiyohi County and at or near Redwood Falls. In many of these years invasions in full force occurred in States farther southward, and the presence of the locusts here was hardly felt in a country little cultivated or barely inhabited. But it is not difficult to collect, in addition to what is already well enough known, statements to show that Minnesota has lain for the last fifteen years too dangerously near to the breeding ground of the locusts, although their visits, in many cases barely reaching beyond the State line, could hardly be called invasions.

Even in 1863 swarms were seen flying as far east as Pomme de Terre River, and Mr. Burdick states that in that year, "In the fall, about the first of November, I was through the country and saw several scouts who informed me that they had seen the hoppers quite thick between here (Willmar) and Kelley's Point (a station in the south part of Meeker County), and also west of here; this must have been late in August or the first of September." All these must have been portions of the swarms which that summer left the marks of their ravages in Dakota, but a few days march to the northwest of Big Stone Lake, where the traces of them were found by General Sibley's expedition. That they also appeared in the Red River Valley, in this and the following years, is shown by the following statement, in reply to the circular No. 1 of the United States Entomological Commission, received from Mr. Robert Probstfield, "the oldest inhabitant" in the neighborhood of Moorhead, giving the years when locusts had appeared there. "In 1863, 1864, 1865 (in 1865 very little damage done; not numerous), 1866, 1867, 1869 (in a few localities bad, in others less, in a few none), in 1870, 1871, bad, 1872 bad, 1873, 1874, 1875, 1876. There are more or less grasshoppers here every year, beginning with 1863, when they came from the southwest early in May, about the 15th or 16th. I came here in April, 1859, there were no grasshoppers here in 1859, 1860, 1861, or 1862." That eggs were laid here in 1863 is shown by his additional statement: "In 1864, the hoppers grew here; there was no grass to speak of, even the whole timber had a wintry appearance in summer, the leaves being eaten and only the leaf-

skeleton left." Compare with this the statement of Geo. Emmerling, of Walhalla, Dakota, "We have had them every year, from 1863 to 1875; they came one year and left us the next, when the young had acquired wings, and so they came and went all the time."

Again, in 1864 swarms appeared early in July, along the Upper Minnosota River, and spread eastward gradually during the season, and reached about as far east as in 1874, *i. e.*, to the third tier of towns in Le Sueur County. Scattering swarms also visited Manitoba in the same year, and probably some portions of these reached Northwestern Minnesota, for we hear of slight appearances of them in the Red River and the Sauk Valleys in 1864 and 1865. But the greater portion of the injury was done in the Minnesota Valley, and was followed by a general departure to the southwest in 1865. The injury in Colorado also was very severe in the same years, but there seems to have been no large movement to the eastward, such as occurred later, in 1866 and 1867.

It seems very likely that the swarms which entered Minnesota in 1864 were hatched at no great distance, and were the offspring of swarms that had alighted in Eastern Dakota in the preceding year. This may perhaps be inferred from the following letter of the Rev. S. R. Riggs, missionary at the Sisseton Indian agency, dated September 9, 1875:

"In 1863, it will be remembered, that on General Sibley's expedition to the Missouri we met with the *ravages* of the grasshoppers in various parts of Dakota, particularly, as I remember, near Skunk Lake (in Minnehaha County), where the large grass had been eaten to the bare stalks, and our animals fared badly.

"In 1865, I visited a camp of Dakota scouts, near the 'Hole in the Mountain,' at the head of the Redwood. That was in the month of August. The valley of the Minnesota clear out to the Coteau was so full of grasshoppers as to make it unpleasant traveling. For the next four years I traveled every summer on the Missouri River, coming over to and from Minnesota. Every season I met with grasshoppers at some point on the east side of the Missouri. In 1867, and also in 1868, we found them near Fort Randall. In 1869, in August, we met them above Fort Sully, near Grand River. In all these cases they were only in small battalions, and appeared to have come there from other parts."

"The invasions of 1871 and 1872 were very scattering, and almost entirely harmless. 'In 1871 they came across the Union River southwest of here, dropping in Pope and Stevens counties (they appeared in several others too), doing some damage, but leaving no eggs save on sandy soil. I do not think their track was more than ten miles wide. In the following spring, 1872, their destruction of crops was total when hatched—perhaps twenty-five or thirty farms twelve miles west of here were cleaned out. They also hatched in considerable numbers between here and Melrose, but left before doing much damage. These came from the southwest and returned.' (J. M. McMasters, M. D.) But they were severe in parts of Becker and Clay counties, as may be inferred from the Detroit (Becker County) Record of August 3, 1872." Last week the great herd of grasshoppers which hatched in and devastated the country north and west of us, came upon this country by gradual approaches, at times greatly increased in numbers by a gentle breeze. They did no particular damage to crops until Saturday, July 27 last, when they took hold as if laying in rations for a four days' march. On Sunday afternoon (July 28), the intense heat of the morning was relieved by a fresh breeze from the northwest. As if by a preconcerted signal every individual grasshopper just got up and shook the dust of Detroit from his feet. * * * The wind did not blow steadily, and they in consequence, wandering and hovering about, settled down for the night. On the following day a steady wind blew from the same quarter as on Sunday, which took them steadily to the southwest and high in the air. Those who witnessed the flight will never forget it; looking toward the sun they seemed like drifting snow from 100 to 500 feet upward. * * * Not a grasshopper remains and they have left no eggs behind.'

1873.—The invasion of this year was something unusual in its character from the earliness of its arrival; the direction from which it came,

and from the fact that it was the beginning of a visitation which has been prolonged to the present time by what, judging from former years, would appear to be unusual circumstances. Each summer since 1873, instead of being the scene of a general departure of the hatching swarms as in former years, has seen portions of those swarms alighting but a few miles from where they were hatched (generally in the next range of counties, and sometimes in other parts of the same county), and depositing their eggs for another brood. They not only appeared in the southwestern counties, but were flying over Detroit in July, 1873, and large numbers of them fell into Otter Tail Lake, and they left eggs on the Sisseton Agency reservation. The Red River Star (Moorhead) of June 28, says: "Grasshoppers are making their appearance on the Dakota division of the Northern Pacific Railroad"; but there is no further allusion in the Star.

1874–'77.—New swarms coming in from the northwest in 1874 and 1876 have added greatly to the area of devastation in both these years, and in the latter year to the area of the egg deposit; but fortunately the heavy rains so diminished the numbers of those that did hatch, that the State suffered in 1877 far less than was apprehended. I am satisfied now that in 1875 there was an invasion somewhere, and that the eggs laid in 1875, as well as in 1874 and 1876, were laid in part by "outsiders." No foreign swarms are known to have flown into Minnesota in 1877; the flight being all out of the State into Dakota, and consisting of the young brood hatched from eggs laid in 1876.

1877.—In Minnesota the young hatched in forty-two or more counties lying mainly in the southwestern quarter of the State, the area, however, not reaching the southwest corner of the State, but in a large number of these so few and so scattering that, owing to a season unusually favorable for the growth of wheat, their presence was hardly noticeable. In the central part of the egg area they hatched in excessive numbers. A portion of the eggs were destroyed by parasites and otherwise during the fall and spring, or at least failed to hatch. Some portion of the young may have been destroyed by cold weather and rains in the latter part of April, but at the time the hatching had hardly begun. During the months of May and June, an unusual amount of rain-fall, well distributed through those months, delayed and in some measure prevented hatching, while owing to the large number of cool, cloudy, or rainy days, on which the locusts were averse to eating, the wheat attained a strong and luxuriant growth, which became every day less capable of being injured. The injury at this time in parts of Minnesota and Northern Iowa was considerable, but the farmers and citizens were battling manfully with their little foes. For a time the prospect in this State was somewhat gloomy, but the encouragement held out by the statement of the commission that this year would in all probability end the present invasion, and the favorable weather, together with the substantial aid and encouragement of the governor and the business men of the cities and towns and railroad companies, induced the farmers to fight the bat-

tle through. In spite of all this, the locusts were so numerous in some counties as to destroy the larger part of the wheat crop, and some eighteen counties in all have more or less loss to report. It is certain that we have never seen of late years anything so nearly like total destruction as that which occurred in two counties last spring[9]; it may be that we have never in any other year had so many bushels of grain destroyed by locusts; but it is certain that in spite of all this, we have never raised so large a wheat crop as in 1877.

After the locusts attained their wings, the first flight noticed occurred on June 15, 16, and 17, passing due north over Rock, Nobles, Murray, and Lyon Counties. "The locusts that hatched in the State commenced to rise during the last week of June, but the principal rising occurred from the 1st to the 7th of July, and during this time the insects uniformly flew to the northwest. From this time on, till early in August, the wind was quite changeable, and the insects appeared to beat about, sometimes going northwest, and at others retracing their course and going southeast and south. Towards the middle of August the winds became more constant from the northwest, and the direction of flight more constant south and southeast." (Riley.)

"The insects that rose after the first week in July (mostly from restricted parts of Minnesota and Dakota) were in many cases borne southwardly and passed over Iowa and Kansas; but up to August 15, did no particular damage. The movements of the insects that bred in Minnesota this year were very similar to the movements of those that bred there in 1876. They at first left to the northwest, but were subsequently brought back and traveled over parts of Iowa, Nebraska, and Kansas. The difference between the two years is, that the flights that thus turned back on their original course in 1876 were recruited and followed by immense and fresh swarms from the northwest plains regions, where, far beyond the boundary line, they hatched and bred innumerably; whereas the Minnesota swarms of 1877 have not been recruited, because there were few eggs laid in 1876 and no insects of any consequence reared in 1877 in said northwest country." (Riley.)

[9] The counties ravaged to a greater or less degree by the locusts in 1877, with their wheat acreage, is as follows, according to Hon. T. M. Metcalf, Commissioner of Statistics for Minnesota:

Counties.	Acres.	Counties.	Acres.
Kandiyohi	35,337	Todd	6,868
Chippewa	15,638	Renville	19,924
Wright	18,747	Sibley	8,799
Stearns	43,294	McLeod	20,315
Nicollet	6,151	Meeker	32,786
Pope	18,218	Yellow Medicine	12,700
Douglas	18,788	Brown	14,215
Swift	13,318	Redwood	6,803
Otter-Tail	30,711		
Stevens	8,106	Total, 19 counties	337,188
Grant	6,470		

THE LOCUST IN DAKOTA.

1853.—The first notice of locusts in Dakota is to be found in Governor Stevens's narrative of 1853 (Pacific R. R. Explorations, vol. xii, part 1, p. 58). He was camped on the Cheyenne River near Fort Totten, and remarks: "The grass at the best is very poor, and the great abundance of grasshoppers has made sad havoc with what had grown here."

Although Dakota was probably overrun by swarms which invaded Minnesota from the northwest in the year 1856, yet, as no mention has been made of the fact, we will not further mention it here.

1863.—"In 1863 it will be remembered that on General Sibley's expedition to the Missouri, we met with the *ravages* of the grasshoppers in various parts of Dakota, particularly, as I remember, near Skunk Lake (in Minnehaha County), where the large grass had been eaten to the bare stalks, and our animals fared badly." (S. R. Riggs in Whitman's Report on the Locust.) Mr. Whitman thinks they were probably the parents of those which invaded Minnesota in 1864. At Walhalla, Pembina County, they have occurred "every year from 1863 to 1875." (G. Emmerling.)

1864.—"We have had them every year from 1863 to 1875. They came one year and left us the next, when the young had acquired wings, and so they came and went all the time." (G. Emmerling, Walhalla, Pemberton County.)

"Last year [1864] about five days' march from the Yellowstone, we met the army of grasshoppers on their way east. After that I suffered greatly for grass and many of my animals died. The grasshoppers made a general clearing out down to this place, and then disappeared." (Extract from letter of General Sully, in Saint Paul Press, June 21, 1868.)

1865–'69.—"In 1865 I visited a camp of Dakota scouts, near the 'Hole in the Mountain,' at the head of the Redwood. That was in the month of August. The valley of the Minnesota, clear out to the Coteau, was so full of grasshoppers as to make it unpleasant traveling. For the next four years, I traveled every summer on the Missouri River, coming over to and from Minnesota; every season I met with grasshoppers at some point on the east side of the Missouri. In 1867, and also in 1868, we found them near Fort Randall. In 1869, in August, we met them above Fort Sully, near Grand River. In all the cases they were only in small battallions, and appeared to have come there from other parts." (S. R. Riggs in Whitman's Report.)

Mr. J. P. Tuller states that late in July, 1868, he observed immense numbers of locusts at Devil's Lake, near Fort Totten, where their bodies formed rows from four to six feet long and two or three feet wide. They caused such a stench that there resulted forty-two cases of bilious fever among the inhabitants. No mention is made of this fact in "Reports on Barracks and Hospitals" of the Surgeon-General's Office for 1870, though it is stated that a "post-garden was attempted last year, but the grasshoppers destroyed the crop." This probably refers to the year 1868.

The presence of destructive locusts is referred to in descriptions of the other forts, but the years in which they occurred are not stated.

1870.—A great swarm of locusts made a descent on the prairies in a portion of Brookings County. (G. S. Codington.)

1871.—A swarm arrived at Berthold July 16, 1871.

1872.—Liberty and Hutchinson Counties, late Union County, were visited by locusts late in August this year. Locusts occurred in Pembina County during 1871 and 1872, according to Mr. Emmerling.

1873.—In June a small number of locusts came from the westward and alighted near Sisseton Agency and deposited eggs, "from which came, in the spring of 1874, an innumerable multitude." (Rev. S. R. Riggs.)

In Union County a cloud of locusts was observed by Mr. Codington, who adds that "Locusts this year did great damage over a considerable portion of Southeastern Dakota, as far northward as in Minnehaha County. In October I rode across the country from Canton, in Lincoln County, to Vermillion, in Clay County, and observed a large number of fields that had not been harvested because the locusts had destroyed the grain." Mr. J. J. Donnelly tells us that in the latter part of July or early in August, 1873, he saw a swarm of locusts flying in the direction of Fort Garry from the headwaters of James River. A lake was filled with their bodies, making the water so putrid that he had to drive the cattle thirty-five miles to get good water for them. Locusts appeared, we were told, at Strawberry Island, 140 miles east of Fort Buford, in 1873, 1874, 1875, 1876, but there were none in 1877. Col. W. Thompson informs us that locusts appeared at Fort Rice (now Fort A. Lincoln) in 1873, 1874, 1875, and 1876, but none hatched in 1877. The more settled portions of the Territory were also visited this year. Dr. Elliott Coues, U. S. A., naturalist to the Northern Boundary Commission, writes me that in 1873 he observed swarms of locusts on Mouse River, in Northern Dakota.

1874.—This was also a locust year in Dakota, although there are no records at hand giving particulars as to invasions. In Capt. W. Ludlow's report of a reconnaissance of the Black Hills of Dakota, in the summer of 1874, it is stated that grasshoppers were observed at Fort Lincoln in June; July 10, immense numbers were seen on the North Fork of Grand River; July 30, grasshoppers appeared at a point eight or nine miles from Harney's Peak, and were seen August 7 in the creek valleys of the hills.

At the Sisseton agency locusts "destroyed all the gardens and wheat-fields in a circle of five miles about the agency." (Rev. S. R. Riggs.)

Mr. Codington writes that 1874 "was the year of most marked devastation." In Brookings County they appeared July 17, "coming down like a thick snow-storm," and left the 19th; but swarms continued to fly overhead, and descending again the last day of July in greater numbers than before, eating everything green; the devastation extended through nearly all the southeastern counties of Dakota. The poverty

and suffering were by no means mythical, as some have seemed to believe.

1875.—During this year immense swarms appeared in Dakota. At Bismarck they appeared June 6 until July 15, inflicting great damage on all crops except potatoes. At Yankton and Fort Sully they were abundant and destructive. The weather-signal observer at Fort Sully reports large flights June 23, passing over during the morning, going north and northwest at an estimated elevation of about fifty feet to as high as they were visible with field-glasses, possibly a mile; none alighting. This swarm, as near as could be ascertained by telegraph at the time, came from the Minnesota infested region, along the line of the Sioux City and Saint Paul Railroad, in a continuous cloud, probably 1,000 miles long from east to west and 500 miles from north to south. How much farther north of this post unascertained and not conjectured. (Riley's Eighth Report.)

Lieut. L. C. Hunt writes from Fort Totten as follows: "In the summer of 1875, grasshoppers hatched in the vicinity of the post took wing in June, and left in the beginning of July." (Whitman's Report, p. 18.) "This year [1875] they have passed over this part of the country, going in a southeasterly direction. One day they lit down in considerable numbers and there is reason to fear that they deposited their eggs," (Rev. S. R. Riggs, Sisseton agency). They did, and a few were hatched there in 1876, writes Mr. Whitman. At Grand Forks the locusts came from the north on or about the 10th of July, and, after remaining three days, arose and flew southeast. (Hector Bruce.) Merrick Moore writes from Jamestown: "Grasshoppers hatched in this county in the year 1875, and the country north and northwest of this place for a long distance was alive with young hoppers. Those hatched here took flight about the 10th day of July, taking a southwesterly direction. Other swarms from the northwest passed over this place high up, bearing a south course. I cannot recall the dates, but they were from about the 20th of July till late in August. Immense swarms appeared, came into Brookings County from Minnesota (Redwood Falls) July 28, on the 30th were seen to be copulating, and August 1 and 2 deposited eggs. It was found that partial destruction had extended down the valley of the Big Sioux River, but nowhere except in the south part of Brookings County had the eggs been deposited. The region of the ovipositing extended eastward into Minnesota." No further trouble from locusts was experienced in 1875. (Codington; see also Appendix).

1876.—This was also a bad year for Dakota. The young hatched out in the northern and eastern portion of the Territory (Bismarck, Pembina), and flying swarms in July and August, and September 1 and 2, were observed at Bismarck, Pembina, Yankton, and Fort Sully, as well as at the following towns: Buffalo, Clay, Hanson, Minnehaha, Richland, and Stutsman. (Monthly Rep. Dep. Ag. 1876.) Whitman states that the young hatched in two eastern counties of Dakota and along the Red

River. In the Little Missouri Valley, on the border of Montana, millions of unfledged locusts were observed May 29. (Whitman's Rep., p. 17.) Along the Northern Pacific Railroad, from Bismarck to Fargo, large swarms were noticed. At Fort Totten some hatched in 1876; swarms visited the region in July, but laid no eggs, and did little damage. Most of the swarms observed in the eastern counties seemed to have come from the northwest, no locusts having this season bred on the James River. The last of July Southeastern Dakota was overrun by locusts, and, on an average, half a crop was saved. (Codington.)

Capt. W. R. Massie, of the Missouri River steamer Red Cloud, informed us, from personal observations, that locusts "hatched out all the way between Bismarck and the Black Hills" in June, 1876. Locusts were observed at Strawberry Island, 140 miles east of Fort Buford, flying at the end of June or early in July, 1876. (S. S. Hughes.)

Extract from letter of Dr. Charles E. McChesney, Fort Sisseton, to Mr. Whitman: "I believe locusts hatched to a very large extent in the valley of the James River in 1876, as I know they did on the Coteau and just off the lowlands for ten miles to the west of this post, which was as far as I visited in that direction last year." "Locusts came here to-day in immense numbers from the northwest." (Yankton: Professor Aughey.)

1877.—Scattered bands of locusts were observed June 21 at Bismarck, and were observed until August 11. (U. S. Weath. Signal Office), which came from the southeast, and were observed as far east as Jamestown, June 18–20. Little or no damage was done this year so far as heard from.

"Locusts hatched in this vicinity in considerable numbers, but did but little destruction." (Dr. McChesney, Sisseton agency.) Rev. S. R. Riggs writes, September 28, 1877, from Sisseton agency, as follows: "While I was on the Missouri River, near Fort Sully, there was an alighting of hoppers about the 10th of this month. They came on the west wind. For several days they were flying, but not in great numbers. They came down and seemed to increase from day to day for several days, until they were very abundant, but, as it was, did but little hurt. On the way over, as we came eastward, we found them on the Missouri Coteau, somewhat annoying in traveling, but in no large numbers anywhere."

At Fort Totten a few locusts were seen in July three or four times. "No eggs have been left in this immediate vicinity." (Capt. A. A. Harbach.) None were seen within seventy-five miles of Lower Brule agency.

At Fort Sully, Capt. Leslie Smith, United States Army, reports, under date of October 6, that "no locusts were discovered as having hatched in this vicinity. Swarms were first seen flying north on the 22d of June, and they continued to fly in a northerly direction in immense clouds until about the 10th of July, when they stopped flying past here. None of the swarms alighted. Grasshoppers have been quite numerous along

the river bottom in this vicinity during the past month, but I am of the opinion that they have been driven in here by prairie-fires that have burned the country for many miles around this post. I observe them copulating quite extensively up to the present date. We had quite a severe frost on the night of the 2d and 3d instant, making ice half an inch thick, since which time some of them have disappeared. I think they have sought shelter in the long grass and weeds. They seemed very ravenous, eating up everything green, and even the small potatoes left on the ground ungathered. I have just this day, for the first time, discovered some few of them depositing their eggs, but I do not think any danger may be apprehended next summer from the small number in this vicinity."

Mr. Whitman reports that very few hatched in Armstrong County, and some died; in Bramble County, May 18, no locusts or eggs were observed; at Scotland, Hutchinson County, eggs were reported within eighteen miles. "New settlers from Yankton to Lake Kampeska, Deuel County, did not see a single grasshopper; there are none in this county. At Grand Forks, "no grasshoppers in this section this year. A few passed over at different times during the month of July, but none lit. No eggs here." In Southeastern Dakota the injury was sporadic and slight, as reported by Mr. Codington.

THE LOCUST IN MONTANA.

1861.—Mr. P. W. Macadow tells us that he observed locusts in Silver Valley, on the Prickly Pear Creek, in large swarms, about the middle of July, 1861. He thinks they hatched out there. They also occurred in this year at Bozeman.

1862.—In August of this year, Mr. J. D. McCammon, tells us that locusts deposited their eggs in the region between Forts Benton and Shaw, and east of south a little beyond Fort Shaw, but they did not hatch out in the spring of 1863. The winter was very mild, there was no snow, and the roads were dusty. In January, 1863, there were very heavy warm rains, and he thinks the eggs were destroyed by the unusually mild weather.

In July, 1862, above the Vermillion Hills, they came from the northwest in great numbers. (James H. Harkness.)

In August, 1862, Mr. James Gomley tells us he observed locusts, in myriads, between Sun River and Fort Benton, flying in a southerly direction toward the Sun River from Fort Benton. They ate up the tall grass so that there was none left for the cattle.

In 1862 large numbers of grasshoppers were observed on Grasshopper Creek, near Bannock City. (James Stuart, contributions of the Hist. Soc. of Montana.)

1863.—Young locusts in great abundance were observed on the Yellowstone River, near where Bear River empties into it, April 26, 1863. (Stuart, Hist. Soc. Montana.) Mr. J. J. Healy states that he saw

in Prickley Pear Cañon, in 1863, flying from the east; they were very destructive to the foliage of trees, &c.

1864.—The locust years at Canton, Meagher County, were 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875. In 1876 no winged locust, plenty of young; and 1877. (W. J. Tierny.) Locusts, then, have appeared at this point for fourteen consecutive years.

1865.—Dr. Lamme, of Bozeman, told me that in 1865 the locusts came to Bozeman late in the season from the northeast, and laid eggs which hatched in 1866. Mr. B. Kline also states that the locusts occurred at Bozeman in 1865 and 1866. At Beartown, thirty miles west of Deer Lodge, locusts came in 1865 in a thick swarm from the northeast. Mr. J. J. Healy, who lives in the Sun River settlement, informed us that locusts came into that valley in July and August, 1865, and laid eggs which hatched out in 1866.

1866.—Mr. George McCullum states that in the Upper Missouri Valley, near Crow Creek, locusts appeared in 1866, 1867, 1868, 1869 (this was the worst year), 1870, 1871, and 1872. None were seen in 1873; but they appeared again in 1874 and 1875 (this was one of the worst locust years), and in 1876 half of the crop was lost. Locusts were abundant and destructive at Bozeman in 1866. (P. W. Macadow.) In the spring they eat up the wheat in the Prickley Pear Valley, south of Helena.

Mr. Chauncey Barbour, editor of the Missoulian, stated to me that in 1866 locusts came into Bitter Root Valley, at Missoula, from the north and northeast and south, from British America, down the Flathead River and over the Main Divide in August, and the eggs laid by them hatched in 1867, and the young were very destructive. None were afterward seen from 1868 to 1874 in Missoula, or to the north or west, until 1875. At Fort Benton they abounded in 1866 and 1867; there were but few in 1868 and 1869. At Hamilton, Gallatin County, no eggs were deposited in 1866, within one hundred miles east or west, north or south, from that locality. (John Potter.) But young hatched out this year in abundance.

Mr. Granville Stuart, of Helena, informs us that he went to Montana in 1857, but he saw no locusts till 1866, when they appeared in dense swarms of unknown extent. They have hatched out in different localities ever since, but not in the same place. The locust years at Deer Lodge were 1866, 1869, 1872, 1874, 1875, 1876. This information extends up to the spring of 1877.

1867–1868.—Locusts arrived in the Sun River region in 1867 and 1868, always coming from the northeast and east, and departing in a westerly and southwesterly direction. (J. J. Healy.)

1869.—Mr. R. M. Goin, of Sterling, observed locusts at this locality in 1869, and also in 1873, 1874, 1875, 1876.

1870.—We were told by a person in Bozeman that locusts were seen in masses on the snow-banks on the Yellowstone Mountains.

1871.—At Fort Benton locusts occurred in abundance in 1871, 1872,

1873, 1875, and 1876, doing the most damage in 1875. (James M. Arnoux.)

1872.—Locusts hatched out at Fort Benton in 1872. None were, however seen at Fort Shaw in June, 1872.

1873.—A swarm of locusts was observed July 10, 1873, in the valley of Davis Creek, in the Yellowstone bad lands, by Messrs. W. F. Phelps and J. A. Allen, as we learn from the former.

1873.—W. Clark states that in this year locusts occurred from Fort Buford westward and up the Yellowstone River. Mr. B. Klein observed a very few locusts in Bozeman in 1873. Mr. J. J. Healy states that locusts came into the Sun River Valley in 1873 and laid eggs, which hatched out in 1874; swarms came in 1875, which hatched out in 1876; the young on being winged must have departed in 1876, this region being free from then in June, 1877. At Fort Benton, locusts have abounded from 1873 to 1876. At Fort Shaw, 1873, 1874, 1875 were locust years. In 1875 they were most destructive. At Upper Missouri Valley, near Diamond City, the locust years were 1873, 1874, 1875, 1876, 1877.

1874.—B. Klein, of Bozeman, states that locusts occurred abundantly in that settlement in 1874, 1875, 1876. Extensive swarms of locusts were seen at Fort Shaw in August, 1874, by Lieut. C. A. Booth, United States Army. No eggs were laid in this year at Fort Benton. (R. A. Miller.)

1875.—Dr. James Shaw, post-surgeon at Fort Ellis, states that locusts migrated there in 1875 and 1876. John Potter also states that dense clouds of locusts appeared at Hamilton July 4, 1875, and laid eggs, hatching out the following year from April 4 to 24. Locusts were abundant at Virginia City July, 1875. (United States weather-signal office.) They also devastated the plains west of Fort Benton, swarms darkening the sun at Sun River.

1876.—Locusts were abundant, though not flying in swarms, in the summer of 1876 along the Yellowstone River. (Lieut. C. A. Booth.) They were observed to be thick on the ground, it being rainy, in July, 1876, at the mouth of the Rosebud River, and for five miles up the stream, by Mr. William Cody, a scout attached to General Custer's expedition. "Officers who passed over the country between the Little Missouri and the Yellowstone Rivers during the spring state that at various points in that region young locusts were found in immense numbers. Shortly before the 23d of July migrating swarms of locusts appeared in the vicinity of General Crook's camp; myriads of grasshoppers filled the air, appearing like an immense drifting snow-storm, tending toward the southeast." (Whitman's Report, p. 17.) Locusts hatched in May at Fort Peck; June 20, swarms arrived from the east. (Hughes.)

Locusts hatched near Helena this year. (James Fergus.) At Hamilton no eggs were deposited in 1876, consequently none hatched in 1877. (John Potter.) General John Gibbon, United States Army, writes us that the locusts which visited Fort Shaw in the summer of 1876 "came

from the southeast, as we heard of them at Camp Baker, eighty or ninety miles southeast of here, before they got here, but they do not appear to have migrated from here at all."

1877.—Locusts hatched out on the north banks of the Yellowstone River from Froze-to-death Creek to Clark's Fork, an area of 100 miles in length. General Brisbin stated to me that young locusts were observed by a party of officers eighteen miles east of Fort Ellis. According to James M. Arnoux, young locusts hatched out in the spring on the Marias River, near the Badger River trading-post (about longitude 113° 10′), but were killed by the heavy rains, &c.

The first swarms seen flying in the Territory were return flights from the east seen at Fort Peck by Mr. S. S. Hughes, acting Indian agent at Wolf Point, who states that "large swarms like masses of clouds arrived June 18, from a point due east; some were seen on the 21st on the ground, having either dropped by the way or been forced back by the west wind, but were hatched in the vicinity of Fort Peck or Wolf Point this spring."

O. C. Mortson reports locusts as hatching out at Benton, but the young were killed by the wet weather. "Ninety miles south of Fort Benton they were in large numbers, coming from the east," August 4, 1877. August 13 and 14, moderate swarms arrived larger ones appeared one hundred miles south.

W. C. Gillett reports July 15, 1877, that no locusts were at Helena at that date, "but in the eastern portion of the Territory they report some as coming."

R. N. Sutherlin reports that no eggs were laid in the Missouri Valley, about Diamond City, in 1876; that swarms came July 24, 1877, into the valleys of the Madison, Gallatin, Missouri, Crow Creek, Jefferson, and Sun River, and an immense amount of eggs were deposited about the 10th of August. There was no damage to crops in Deer Lodge and Missoula Counties, and no eggs were deposited there.

Dr. S. S. Turner writes from Fort Peck, June 30, that the locusts are "numerous here at present; have been copulating for several days. They were hatched here before my arrival."

In passing through Montana, from Franklin to Fort Benton, in June, no young were observed or heard of, and the inference to be drawn is that few eggs were deposited in the previous summer in Central Montana, except in the Bitter-Root Valley. Eggs must have been deposited numerously along the Yellowstone and its tributaries to afford the supply of locusts that, in July, 1877, swarmed in Central Montana.

Mr. G. W. Norris, superintendent of the Yellowstone National Park, writes us (under date of February, 1878,) that, in passing up from Bismarck to the Yellowstone Park, he saw locusts, "the first of the season," on Custer's battle-field, July 5. "Their line of flight was a little south of west, as I passed out of it at the mouth of the Big Horn, and again entered it at Pompey's Pillar, July 12, and continued in it, but reaching

its front at the mouth of Shield's River, the 17th. I then left them in a strong west wind, steering up Shield's River, and also through Bozeman's Pass to the Gallatin Valley, while I passed through the gate of the mountains to Bottler's Park, which, with the National Park, they did not enter, nor have they but once, viz, in 1875, since 1868. From July 22–24, I saw them numerous and destructive in the Gallatin Valley, where it was estimated that they destroyed at least one-third of the gardens, oats, and barley, but much less of other products. They soon after scattered and strangely vanished, laying few eggs, nor did I learn of any being deposited anywhere upon my return down the Yellowstone and Missouri to Bismarck, and along the Northern Pacific Railroad to Duluth, and hence think there is little prospect of damage from them this year."

THE LOCUST IN IDAHO.

It may be regarded as a general rule that when Northern Utah is visited by locusts, they have mainly come from the Snake River Valley in Eastern Idaho. Facts regarding the history of the locust in this Territory are very scanty, and additional data are extremely desirable.

Mr. W. N. Byers gives us the first published information on this point. He says: "In 1852, I first observed the insect in question in the valley of the South Fork of the Columbia River, not far from Fort Hall. A swarm lasting two or three days passed over from west-southwest, moving with the wind, at times darkening the sun, covering houses, cattle, and wagons, against which they were driven. The Digger and Snake Indians were gathering them for food." (Hayden's U. S. Geological Survey, Wyoming, for 1870.) Mr. J. K. Lum tells us that late in July or early in August, 1852, he saw locusts in the Bear River Valley, and westward near Fort Hall (at Portneuf Cañon and Soda Springs in the Montana road). Mr. W. L. Morton also told me that in 1852, in traveling on the emigrant road in Bear River Valley, between Blue Springs and Lost Springs, he was one hour passing through a swarm of locusts flying northward.

That the locust has periodically infested the Snake River Valley about Boise City is intimated in the following statement by Drs. Jaquett and Moffatt, United States Army, in "A Report on Barracks and Hospitals, with Descriptions of Military Posts":[10] "The most formidable foes of the agriculturist in this region are the cricket or grasshopper, or both, in countless numbers during the month of May or June. Their track, when in full force, is marked by the utter destruction of all verdure."

At Boise City, according to Rev. William Bollard, eggs were laid by locusts in 1869 and 1870; the swarms traveled west. The locust years at Boise City were 1869, 1870, and 1877.

According to our observations the locusts hatched out in more or less

[10] Circular No. 4, War Department, Surgeon-General's Office, Washington, December 5, 1870. 4°, p. 426.

abundance from Franklin to the Montana line along the stage-road. July 20, 1876, Mr. Wood saw a large swarm of locusts near Camas Creek, on the stage-road to Montana, flying south of east. Mr. J. B. Porter, of Helena, states that July 20, 1876, while stopping for refreshments at Sand Hole, on the stage-road south of Pleasant Valley (this is a station not far from Camas Creek and north of Market Lake), a swarm of locusts came with a roar like a cloud, obscuring the sun, flying nearly from north to south, and over an hour in passing. In early June, 1877, we were informed by the Right Rev. Bishop Tuttle that locusts bred in considerable numbers this spring at Boise City. Later in the season they proved, according to our informant, Mr. C. C. Wheeler, very abundant and destructive to crops in the Bruneau Valley, southwest of Boise City. The 2d of August they were observed at the upper or southwest portion of the Bruneau Valley.

THE LOCUST IN WYOMING.

1842.—Frémont,[1] July 21–28, 1842, encountered a swarm of locusts in the North Platte Valley, at the present site of Fort Fetterman. He says, "This insect has been so numerous since leaving Fort Laramie that the ground seemed alive with them, and in walking a little moving cloud preceded our footsteps. They had probably ceased their flight, and were preparing to deposit their eggs." (P. 50.) "The great drought and the plague of grasshoppers had swept it so that scarce a blade of grass was to be seen, and there was not a buffalo to be found in the whole region. The Indians had been nearly starved to death, and we could find their road marked by lodges which they had thrown away in order to move more rapidly, and by the carcasses of the horses which they had eaten, or which had perished by starvation." (P. 53.)

1846.—"The late Mr. J. B. Wall, collector of Monterey, informed me that in a journey from Oregon to Missouri, in 1846, his party encountered in July, on the plains near the north fork of the river Platte, myriads of the grasshoppers, which all appeared to be travelling northward, and proved extremely annoying to the train for many days. Bryant, in his 'What I saw in California,' relates that on his passage to California, under dates of July, 1846, their company of emigrants also encountered immense swarms of grasshoppers on the prairies near the Platte." (A. S. Taylor, Smithsonian Report for 1858, p. 204.)

1847.—Mr. A. L. Siler writes us that Mr. William Casto told him that he saw locusts on the Cache la Poudre, between Larimer and the North Platte River, in 1847. This locality would appear to be within the limits of Wyoming, but may be situated within the Colorado line.

1855 or 1856.—Mr. W. M. Hinman writes to the Smithsonian Institution, under date of June 10, 1861: "Five or six years ago they were bad in Utah; the next year they were bad at Fort Laramie."

[1] A report on an exploration of the country lying between the Missouri River and the Rocky Mountains, on the line of the Kansas and Great Platte River. Washington, 1843.

1857.—"In August, 1857, large quantities came with a southwest wind and stopped at the United States saw-mill near Laramie Peak." "I think it was about the 26th, 27th, and 28th they came. They were very plenty, but did not destroy much; for a week or more they were cohabiting." (W. M. Hinman, in a letter dated June 10, 1861, addressed to the Smithsonian Institution.) A correspondent of the New York Tribune, in a letter dated Fort Kearney: August 31, 1857, writes, "Last Friday a swarm passed over the fort which darkened the sun so as to render it possible to gaze at it with the naked eye. We saw this swarm at a distance of ten or twelve miles, at which it resembled a cloud of smoke." (Smithsonian Report for 1858, p. 203.)

1870.—Professor Thomas, August 20–23, while travelling with a party of Hayden's United States Geological Survey, up the North Platte, between Fort Fetterman and Red Buttes, observed vast numbers of locusts, many of them pairing.

1873.—Capt. W. J. Jones states in his "Report upon the Reconnaissance of Northwestern Wyoming," made in the summer of 1873, that in the Green River Basin "the region is infested with great swarms of grasshoppers." Mr. Louis Wyatt, of Greeley, Colo., told me that in the middle and last of August, 1873, he saw great numbers seventeen miles west of Cheyenne. In August of the same year he rode through immense numbers flying east through Bridger's Pass. "In 1873 I found them in different parts of Western Wyoming, between Fort Bridger and the Yellowstone Lake; but on the plains bordering the Stinking Water River, in July, they were more abundant than I had ever seen them elsewhere before."[12] He also saw them in July in the Wind River Valley, as he writes us.

1874.—Locusts were seen flying at Laramie City; but few breed here. Colonel Shattuck informs us that the locust hatched this year thickly in the Laramie Valley, and indeed "all over the Laramie plains."

1875.—August 8, at Cheyenne, locusts were observed in great numbers moving from the northwest. (U. S. Weather Signal Service.) August 10, 1875, it was reported from Laramie City that vast clouds of locusts were flying southward. (Riley's Eighth Report.)

1876.—At Cheyenne grasshoppers hatched out in the spring, and were reported to the Agricultural Department as alive May 14, and abundant August 7–31, and a few were seen flying October 3. Mr. Dobbin, the United States signal observer, said young hatched out in abundance and the winged ones were seen very thickly June 27. August 7 and 8, swarms came in abundance, the main body arriving on the 8th and were seen till October 3. Mr. Benj. Eaton tells us that locusts hatched this year in great abundance on Laramie plains. At Camp Brown, in Little Wind River Valley, a fine farming region, locusts were very abundant. At the Black Hills they bred, and flew afterwards in great quantities. (B. Eaton.) Mr. Robert E. Strayhorn told us that while attached to

[12] J. D. Putnam, in Packard's report on the Locust, &c. Hayden's annual report for 1875, p. 601.

General Custer's expedition, in July and August, 1876, he saw about the 1st of July, on Goose Creek, at the base of the Big Horn Mountains, northwest of Fort Phil. Kearney, a swarm of locusts like clouds of smoke, which were mistaken for a prairie fire. They were passing to the southeast. He also, May 29, saw the young about one-half grown on Sage Creek, thirteen miles north of Fort Fetterman.

1877.—Mr. E P. Snow told us that May 20 he saw a large number of young locusts which had hatched out in Pleasant Valley, nine miles south of Custer. None were observed breeding at Cheyenne this year. Mr Davis tells us that locusts were seen in the Black Hills at Belle Fourche, and on the Spearfish River, June 16 and 17, flying toward the west. A few locusts were observed in June at Camp at Red Cañon, forty miles distant from the Black Hills. (Capt. W. S. Collier, U. S.A.)

From a point fifty miles north of Laramie City to Custer, especially in Red Cañon, young locusts were observed in abundance. (Colorado Farmer, May 31.)

At Rock Creek Station, August 3 and several weeks after, locusts flew, coming in all directions ,the largest swarm from the east. At Como Station a small flight of locusts passed over July 15, flying in a southeast direction. (W. E. Carlin.) Large numbers were reported at Fort Reno during June. (Capt. E. M. Coates, United States Army.) Great numbers of locusts hatched on Hay Creek. (Dr. A. P. Frick, United States Army.)

THE LOCUST IN COLORADO.

The earliest records of locusts in Colorado do not extend back of the year 1864, as previous to this there were very few if any farms.

1864.—Large swarms of locusts invaded Colorado from the northwest and north, late in August. (Byers and Arnett.)

1865.—The young, hatching from eggs laid in the previous autumn, "destroyed nearly all the crops." "August 5, 1865, an army of grasshoppers came and harvested the oats almost entire, leaving but a small amount of wheat, and nothing else." (Arnett.)

1866.—"In 1866 they came, I think, on the 9th of September; they deposited a large amount of eggs in 1866, which did much damage in the spring of 1867." (Arnett.)

1867.—A large portion of the farming region of Colorado was invaded this year, the swarms, according to the information received from Mr. Byers, coming from the west over the range.

1869.—The locusts this year were, according to Professor Thomas, "comparatively abundant in Colorado, and even in San Luis Valley," and a few were seen south of the Raton Mountains.

1872.—During this year locusts are reported to have been abundant in Middle Park, on Parry's Peak, above timber-line, and among the mountains at Empire City, and were quite plentiful on the plains between Denver and Boulder. (J. D. Putnam.) Several persons at Greeley

told us that locusts were abundant in that region in September of this year.

1873.—Locusts hatched out in large numbers in the spring about Greeley, but we have been unable to learn that any considerable injury was done to crops.

1874.—This was a notable locust year in Colorado. Great swarms were observed by Professor Robinson at Golden City and Denver in July; much damage was done July 8–11 at Valmont, and they extended south to Cañon City. (J. D. Putnam.) Eggs were deposited in great numbers in North Park "countless numbers of young appearing there"; (Byers), showing that, in 1875, Colorado was probably visited throughout nearly its whole extent.

1875.—The farmers of Colorado probably suffered more this than any other year from the attacks of young locusts, which hatched from eggs laid by the swarms which visited the agricultural portion of the State in the previous year. At Boulder the injury was light; at Caribou (elevation 9,167 feet) the first crop was destroyed. They abounded all over Northern and Central Colorado, in the plains and among the mountains, as far south as the La Plata. The winged locusts in August were very abundant about Denver and Greeley. From the 20th July to the end of August swarms repeatedly passed over Denver. (United States Weather Signal Observer.) At Manitou hordes were observed by Mr. Uhler, August 13–16, and he saw large numbers at Cañon City. The writer observed them about Denver, in the mountains about Caribou, Nederland, Georgetown, Idaho Springs, and Manitou, as well as on the summit of Pike's Peak in July and early August. At Boulder a swarm came from the northwest late in August, and at Greeley swarms arrived from the west and northwest August 25, laid eggs for three days, and left on the 28th August. (J. Max Clark.)

1876.—The locusts hatched in abundance this year from eggs laid in the previous summer, but crops were saved wherever proper exertion was made. In harvest-time, August 2 and 3, swarms arrived from the north and north-northeast, and flew in a southwesterly direction, and when last heard from had reached the headwaters of the South Arkansas and Rio Grande Rivers, especially from near Grenada to Cañon City, the last swarm depositing vast quantities of eggs. During the whole month swarms arrived, and it is supposed by Mr. Byers that all were immigrants, the earlier swarms coming from Wyoming, and the later ones from Western Dakota, Eastern Montana, and perhaps from British America. Mr. Arnett gives the following summary of the invasion in this State: "Now, the only difference in their visitations in 1864, 1865, and 1866, between that of 1874, 1875, and 1876, is this: In 1874 they came thirty-five days sooner than in 1864; in 1875 they came ten or twelve later than in 1865; in 1876 they came forty-two days earlier than in 1866. From 1867 to 1874 we had but few losses from them. A light band occasionally did a little harm. Their movements in all

respects, in 1864, 1865, and 1866, have been precisely duplicated in 1874, 1875, and 1876, and from this I conclude we shall have six or seven years' rest."[13] Mr. Holly reports that Saguache Valley suffered from two different swarms in 1876.

"In Lake County is an extensive section of cultivated land lying along the main Arkansas. For four years the ranchmen have been 'eaten out of house and home' by the hoppers. In 1876 strong hopes were entertained that they would be exempted from the dreaded scourge, but in July and the first weeks of August vast swarms came from the southwest in such numbers as to preclude any attempt to prevent their ravages. Every green thing was eaten except peas (a portion of the crops had been harvested). The insects remained about fifteen days and passed off to the east. The adjoining county of Park suffered considerably, especially the pasturage. The valley of the San Juan River, both in Colorado and New Mexico, as far as the boundary-line of Utah, suffered very little in 1876, and the early brood of locusts in 1877 disappeared without doing material injury. * * * I returned from the San Juan Valley by the way of Conejos and Costilla Counties. These extensive sections are principally devoted to pasturage, and have not been much injured. Late crops have, however, uniformly been cut off." (Mr. Holly. See App. 7.)

1877.—As eggs were deposited in immense numbers the previous summer, it was feared that the crops would be universally cut off in the spring and early summer of the present year. Happily, owing to the unusually heavy rains, accompanied by a light fall of snow, together with cold weather late in April and early in May, the young, which hatched by millions in the spring, were destroyed in the same manner as in Kansas and Nebraska. Parasites and insect enemies also aided in the work of destruction, so that little injury was committed by the young locusts, and Colorado raised a large crop of wheat. This refers to the plains on which Greeley and Denver and neighboring towns are situated. In Lake County, where there is an extensive area under cultivation along the Arkansas, and where the damage was great last year, few locusts hatched the present year. In Park County, mostly devoted to grazing, the injury has been very slight.

The San Luis Valley, which is devoted to agriculture and stock-raising, has suffered little, and Ute Valley has also, as is usually the case, been singularly free. In the Wet Mountain Valley, which is specially subject to injury, the farmers had to fight locusts early in the season; and the injury in the valley of the Costilla, where fields were ravaged by the young locusts, was greater than in any other part of the State. The severe injury extended southward into New Mexico, where the valley of the Taos has been swept clean. Yet, on the opposite side of the mountain, the President of the New Mexico Stock and Agricultural Association reports no injury, the young insects having disappeared.

[13] *Colorado Farmer*, September 7, quoted in Packard's Report on the Rocky Mountain Locust, &c., Hayden's Report of the U. S. Geological Survey for 1875, p. 622.

While in the lower plains and valley regions of the State the conditions have been so similar to those which prevailed toward the Mississippi, they have been quite different in the higher plateaus and parks. At altitudes at from 8,000 to 9,000 feet above the sea, the principal hatching occurred in May, and was later in proportion as we ascend, until in the passes, with an altitude of 12,000 or 13,000 feet, the insects hatch in July. At such great heights the mature dead are often to be found in large quantities under stones and other shelter, and their young occur in great numbers. As no agriculture is carried on in these parks and passes, no effort is made to destroy the insects.

For the first time, however, in the history of the State, dense swarms of locusts came from the south (probable return flights from Texas and Indian Territory and perhaps Kansas), entering the northeastern corner of the State at Julesburg May 28 and 29. There are no previous records of such flights from this direction or from such a point of the compass. Nothing definite was heard from these flights afterward, except reports of locusts alighting at Deadwood, Black Hills; and their force was probably expended or scattered over the plains. Similar northward-bound swarms were observed about the same time at Wallace and Evans, Kansas, and about the second week in June flights from the south reached Deadwood, in the Black Hills.

In the second week in June there were also flights of locusts over the eastern part of the State, which are said to have come from the south. At La Porte, in Larimer County, there were "swarms from the northwest to southeast in August, but I think they came only a short distance." At Pueblo "a few swarms were observed in the early part of July, passing over from the north or northwest. None of them came down." A few locusts were observed at Larkspur, in Douglas County, but none at Colorado Springs; and at Georgetown our correspondent states that "no swarms from the north, northeast, or northwest passed over this district." At Denver "there were no fresh swarms from the north, northeast, or northwest. In the latter part of July they passed over here for two days, flying northeast."

THE LOCUST IN UTAH.

Utah was for the first time, so far as known, visited in 1851, as we were informed by Brigham Young, late president of the Latter Day Saints. Ogden was also visited the same year and much damage was done. (F. A. Brown.)

1852.—Locusts were observed on the plains of Northern Utah and Southern Idaho about the first of August, 1852, by Mr. W. N. Byers. No information, however, has been obtained by settlers in Utah relative to the movements of the locusts this year.

1853.—Mr. A. L. Siler, of Ranch, Kane County, says that locusts flew into the Salt Lake region in this year, coming from the east, in July.

1854.—Ogden and Logan, Salt Lake City, Nephi, and Spanish Fork, Utah County, are reported to have been visited this year.

1855.—Locusts were more wide-spread and destructive this year than any other, perhaps, excepting the year 1867. Reports of their devastations have been received from residents of Plain City, Weber County, which afterward enjoyed a respite for twelve consecutive years, *i. e.*, until 1867. Salt Lake City and Nephi were also afflicted by them. They also appeared in Spanish Fork City, at Beaver, in Southern Utah; they came in August, 1855, and destroyed nearly the entire crop; but the crops were good in 1856. Payson was visited in 1855, and damage was done by locusts in 1866. It is evident that Northern and Central Utah were overrun by them this year. "After the crops were destroyed, there was not time to get grain from any quarter. The people had to husband their supply to keep the wolf from the door until another harvest; a great many living upon roots, greens, and, in fact, anything that would sustain life. The harvest of 1856 furnished plenty; the grasshopper war was over." (Salt Lake Herald.)

1856.—Ogden suffered this year and for each successive year until and including 1870 (John I. Hart); also Salt Lake City and Payson. It thus appears that Northern Utah, *i. e.*, from Ogden to Idaho (Cache and Malade Valleys), has suffered for sixteen years in succession, from 1854 until 1870, but in Central and Southern Utah, *i. e.*, south of Salt Lake City and vicinity, there are no reports of destructive locusts during the years 1857–1863.

1857.—The locusts "ate everything green in Salt Lake Valley." (Iowa Homestead.)

1863.—No reports of destructive locusts south of Ogden; at this time they were noticed each year from 1863 until 1870.

1864.—Swarms of locusts visited Salt Lake City and vicinity, and Ogden.

1865.—Swarms appeared at Beaver, in Southern Utah, in the autumn.

1866.—Beaver was again visited by swarms, which laid eggs, and their young appeared in 1867, and locusts abounded in the years 1867, 1868, 1869, 1870, and 1871, small crops being raised. Payson was visited in 1866, and suffered for five successive years, *i. e.*, until 1871. Logan and Smithfield, Cache Co., suffered this year more perhaps than other settlements outside of Cache County.

1867.—This was, like 1855 and 1860, one of the worst locust years in Utah. The trouble extended from Cache County, where half the grain was devoured, to Salt Lake and in the desert county of Juab at Nephi, as well as south to the town of Beaver. At Saint John's, Tooele County, great swarms came late in the summer, large numbers hatched in 1868, and swarms appeared in 1869, and many young appeared in the spring of 1870; this year being the most calamitous. At this settlement some farmers did not raise a crop for seven successive years. "These locusts arrived in the northern part of this Territory the summer before last and deposited their eggs. These generated the following spring, and immigrated to this city and surroundings last autumn; they deposited their

eggs here, and this last spring they hatched out in numbers beyond calculation."[14] Their progeny was destructive about Salt Lake City in 1868.

1868.—Besides the points already noticed, locusts arrived at Heber, Wasatch County, in a swarm "like a cloud." They were also destructive at Salt Lake City and vicinity, and at Croydon.

1869.—Cache County, and Salt Lake City, Croyden, Morgan County, as well as the other settlements previously mentioned, were visited this year.

1870.—This was a calamitous year in Cache, Weber, and Wasatch Counties, *i. e.*, in Northern Utah; Ogden, Weber, and Plain City, being visited by them. Professor Thomas states that locusts abounded in the Territory in 1870 and for three years previous. In this year locusts apparently prevailed throughout the entire extent of the Territory.

1871.—After abounding in Northern Utah the locusts may usually be expected the following year in Central and sometimes in Southern Utah. Southern Utah was infested by them more this year than any other known. They were observed in Kanab and Hebron, Washington County. At Silver Reef but few eggs were deposited, but they did much damage to orchards, vineyards, and gardens. At Paragoonah locusts laid eggs in abundance in 1871 and in 1872; one-half the crops were destroyed by their progeny. (Dr. E. Palmer.) Locusts also abounded, according to Professor Thomas, in the northern parts of the Salt Lake Basin, particularly in Box Elder Cañon and Cache Valley. Salt Lake Basin, early in August, he found to be "swarming with myriads of these grasshoppers, and even after we had passed eastward on the railroad to the heights near Aspen Station, I noticed the air filled with their snowy wings, but could not tell exactly the course they were taking, but thought they were moving southwest."

1872.—We have no information from unpublished sources that the locust did any damage this year, but swarms are reported in a Utah paper as leaving the Territory in August and September, 1872.

In 1873 and 1874 there were no locusts observed in Utah. In July, 1875, a few indigenous locusts (*Caloptenus spretus*) were observed by the writer at Lake Point, Salt Lake. None were observed by Mr. J. D. Putnam at Spring Lake Villa, about 70 miles south of Salt Lake City. Mr. Alexander Stalker, of Franklin, Utah, informed us that the locusts flew into Malade Valley in 1875.

1876.—Swarms of locust, early in October, settled down at Logan and Smithfield, Cache County, Croydon, Morgan County, and at Salt Lake City, extending at least three miles south of the city.

1877.—The young hatching from eggs laid the previous autumn did some injury to fields at Farmington; several fields of wheat were injured at Saint John. Much damage was done in Cache and Malade Valleys. If the wet weather had not destroyed a large percentage of the young, especially in Morgan, Davis, and Salt Lake Counties, as well

[14] California Farmer, August 20, 1868.

as Cache and Malade Valleys, serious damage would have resulted, showing that the invasion was a formidable one in 1876.

We find, in conclusion, that while Southern and Central Utah are more or less exempt from locust invasions, Malade and Cache Valleys and Weber County have been infested fourteen out of the past nineteen years.

THE LOCUST IN NEW MEXICO AND ARIZONA.

That it is common and destructive at times in New Mexico is shown from the statement published in the Monthly Report of the Department of Agriculture, at Washington, D. C., for July, 1876, where it is stated that the corn and oats were injured and the wheat-crop half destroyed by the "grasshopper," which must be *C. spretus*, as Taos is near the Colorado line. Mr. Thomas reports a few specimens of *C. spretus* from New Mexico and Arizona in collections made by Lieutenant Wheeler's Expedition during the last four years, and he himself found a few specimens south of Raton Mountains in 1869. In 1875, however, Lieutenant Carpenter, as he writes me, did not see any swarms in the region extending from Fort Garland to Santa Fé. "I could not learn," he adds, "that they had ever been troublesome in Northern New Mexico."

Mr. B. Eaton, of Greeley, informed us that locusts were very abundant in Taos thirty-five years ago, and in 1864 and 1865 they eat up the crops in Taos.

In Northern New Mexico Lieutenant Carpenter found this species (identified by Mr. Scudder) on Taos Peak, Sangre de Cristo Mountains, at a height of 13,000 feet (above timber-line), in July, 1875. (Scudder, in Wheeler's Annual Report for 1866. See Packard's report to Hayden.)

Mr. Holly reports that the portions of New Mexico adjacent to Colorado have been injured very little. "The president of the New Mexico Stock and Agricultural Association informed me that no trouble was experienced by his colony (in Colfax County) in 1876, and up to June 15, 1877, were entirely free, while on the opposite side of the mountains the Taos Valley had been swept clean." Mr. Holly writes that incursions next year of grasshoppers are feared in the San Luis Park and adjoining sections from this direction.

THE LOCUST IN NEVADA.

Mr. Daniel Bonelli writes us, under date of June 26, 1877, that Saint Thomas, Lincoln County, Nevada, was visited by what may have been this species in 1870. He says: "The particular locust you are inquiring after does not seem to thrive here, not having visited this region since 1870, at which time a large swarm came from the northwest and laid eggs in a sandy mesa in August, while the heat in the shade was 116° and in the sand hills in the sun 160°; all the eggs melted like lead in hot coals, and that class of 'hopper (Rocky Mountain locust) has not appeared since." Saint Thomas is about 40 miles southwest of Saint George, Utah. Locusts were abundant in Utah this year.

The following facts regarding the occurrence of *Caloptenus spretus* in Nevada, in 1871, were observed by Mr. Thomas:

I saw *C. spretus* in 1871 in abundance along the Humboldt River in Nevada, most of the way from where the Central Pacific Railroad strikes it (going west) to the sink or place where it disappears. At one point they were quite abundant, and evidently preparing to migrate, flying up in the air, their wings presenting that peculiar glassy snowy appearance with which you are no doubt familiar. This, if I recollect rightly, was west of Humboldt Station; they were quite abundant at that station (Humboldt), where we dined (going west), but were not migrating there or then; those referred to as seen west of Humboldt being seen as we returned east. You probably remember that saline or alkaline belt at the northwest extremity of Great Salt Lake; just beyond that I began to observe them, and from thence—not continuously, but at certain points—from there to, and a short distance west of, Humboldt Sink. The collections made by Wheeler's party in Southeast Nevada had no specimens which I could positively say came from that section. That year (1871), as we went out (June) we saw but few specimens in Salt Lake Valley, but they were quite numerous when we returned from California in August. They were also numerous in Cache Valley and Southern Idaho; in moderate numbers west of the range in Montana as well as east.[15] (Packard's Report.)

In 1877, for the first time within the knowledge of the settlers, locusts invaded the northern limits of Nevada. Mr. C. C. Wheeler states that on the 5th and 6th of August they appeared in Nevada, flying in great swarms, eating the crops in the Owyhee Valley, seven miles northwest of Cornucopia, Nev. These swarms most probably came from Bruneau Valley in Idaho, the distance from Cornucopia to the Bruneau Valley being only about one hundred miles in a northeast direction.

THE LOCUST IN OREGON AND WASHINGTON TERRITORY.

West of the Cascade Mountains no migratory locusts, however, have been known to exist, according to W. Byron Daniels, of Vancouver, Wash., and D. M. Utter, of Olympia. The only authentic accounts of past ravages I could obtain was a statement made to me by Mr. J. K. Lum, that a grasshopper of an unknown species was very abundant at Skookumchuck, Lewis County, Washington Territory, in August, 1856, eating the heads of wheat. It was not observed elsewhere. Grasshoppers are said by A. S. Taylor (Smithsonian Report, 1858) to have been destructive in Oregon in 1852 and 1855. As the species are not mentioned, nor the locality, it is not improbable that Taylor referred to a local species (perhaps *Caloptenus atlanis* or *femur-rubrum*, or both) west of the Cascade Mountains.

We have more authentic information regarding the appearance of the genuine Rocky-Mountain locust in Oregon and Washington Territory, east of the Cascade Mountains, though there are no data to show that *Caloptenus spretus* has occurred west of longitude 118° 30′ west. From J. A. Willson, Indian agent at Fort Simcoe, Washington Territory,

[15] It will be exceedingly desirable to trace the distribution of *C. spretus* southward of the present known limits, for it is not at all unlikely that it inhabits the northern edge of the Mexican plateau, since Major Powell informs us that he found a locust, as he thought this species, numerous within twenty miles of the Mexican boundary on the Colorado River.

situated on the eastern side of the Cascade Range (longitude 120° 50′), and due north of Celilo, I learn that that locality has not been troubled with locusts. Mr. D. S. Baker, president of the Walla Walla and Columbia Railroad, writes us that the Valley of the Walla Walla River "has not since its settlement, in 1860, been seriously affected by Rocky-Mountain locusts. The Pataha River country, some forty miles (northeast, near Lewiston) distant from here (Walla Walla), year before last (1875), as well as last year (1876), was visited in some small districts with grasshoppers, injuring some crops materially."

In Jordan Valley, Baker County, Oregon, a swarm of locusts "five miles wide and five miles long" appeared July 29, 1877, destroying nearly all (ninety per cent.) of the grain in the valley, and deposited their eggs August 10. (W. F. Gwinn.) Still more direct information is afforded by a letter (dated November 10, 1877) from Mr. Henry Heisy, of Clarksville, Baker County, Oregon, who says that on or about the first of August the forerunners of swarms of grasshoppers appeared, which came in full force on the 13th August, darkening the sun. They came from the southeast, and departed the middle of October in a northwesterly direction, having deposited eggs October 1. Previous to this year there had been no locusts in that section "for the last ten years." Philip Ritz, of Walla Walla, writes us as follows: "We have never been visited by the grasshoppers within fifteen years that I have lived here to do any damage, but a number of emigrants which came here late last summer told me they saw myriads of them in the air flying north, and a few specimens which they examined were the identical grasshopper of Kansas and Nebraska." Mr. J. H. Kunzie, of Umatilla, writes: "No 'hoppers within a circuit of 100 miles around this locality. Boise City, Ada County, Idaho, and Lewiston, Idaho, and thereabouts, are the only locations where 'hoppers are at home."

At Camp Harney the locust abounds occasionally, as stated by Drs. Styer and Byrne, United States Army, as follows: "Owing to the occurrence of severe frosts during each month of the year, together with immense swarms of crickets and grasshoppers, it has been found impossible to cultivate a garden with any surety of success. For two seasons the attempt was made and the result proved but a total loss. (Surg. Gen.'s Rep. on Barracks, &c, with description of military posts, 1870, p. 438.) This is the most western point to which the locust has been traced, *i. e.*, longitude 118° 30′.

Dr. J. H. Bartholf, United States Army, writes from Camp Harney, Oregon:[16] "The Rocky-Mountain locust has not been here or in this region thus far this year nor the three preceding years." In July and August, 1877, the locust appeared in swarms in the Burnt River Valley, a few miles southeast of Baker City. (See Appendix.)

[16] This locality is about 175 miles south of Umatilla, in longitude 118° 30′ W., latitude 43° 30′ N., and situated in the eastern flanks of the southern extremity of the Blue Mountains. Its elevation is 4,200 feet above the sea.

THE LOCUST IN BRITISH NORTH AMERICA.

North of Montana.—A large proportion of the locusts which fly into Montana about Forts Benton and Shaw come from north of the United States boundary-line, and the years in which the locusts have abounded on the northern side of the Upper Missouri River, in Montana, were probably locust years in British America north of this region.

"A correspondent at Carleton House, on the Saskatchewan, in speaking of the grasshopper, thus writes: 'The day in which you say they made their appearance at Red River I left Carleton House for Fort Pitt,[17] and all the way up they were very numerous, and about the latter end of August they were flying south in great numbers.' They were also last autumn at Fort Pelly, in the Swan River district, and no doubt they have deposited their eggs in all the barren ground (prairie) between Fort Pitt and Red River. They did not extend to the Winnipeg River, but myriads of them were drowned in Lakes Manitowaba and Winnepeg." (This was apparently either in 1864 or 1865.)—(Letter of Donald Gunn to S. H. Scudder, dated April 17, 1868.)

1873.—Locusts laid eggs in the region about Forts Browning and Belknap, and flew in a westerly direction. (James M. Arnoux.)

1874.—During the summer of this year, Dr. Elliott Coues, U. S. A., naturalist of the United States Northern Boundary Survey, as he writes us, "saw vast swarms in 1874 about one hundred miles north of Fort Benton."

1876.—Mr. James M. Arnoux, of Fort Benton, informed us that in June and the fore part of July, 1876, locusts occurred in swarms from an immense region about Fort Benton, extending from latitude 47° 50′ to latitude 49° 30′ (approximately), and from longitude 109° westward to the base of the Rocky Mountains in longitude 113° 30′, being especially destructive about the headwaters of the Marias and Milk Rivers, in approximate longitude 113° 30′, where they "were so thick and hungry as to eat the bark off of the willows." The movements of the swarms were directly *east*, an exception to the ordinary rule, said Mr. Arnoux, as about Fort Benton they usually fly from the northeast in a southwest direction. (It is obvious, however, that north of the boundary-line the locusts most usually fly, when in sufficient numbers to migrate, toward the south and east, as none are known to exist in swarms in the forest region west of the mountains in British America.)

At Belknap, ninety-six to one hundred miles north of Fort Benton, and at Fort Browning, one hundred and fifty miles northeast of Fort Benton, there were this year observed swarms of locusts, which, at the end of June and early in July, were observed flying eastward. In this same year locusts were said by Mr. Arnoux to extend north by west several hundred miles from Fort Benton toward Fort Edmonton, but they were most abundant from eighty to one hundred miles north of Fort

[17] Fort Pitt is situated on the North Saskatchewan, in latitude 53° 31′.

Benton. May 24, 1876, a foot of snow fell in this region, but the young locusts were not killed. Mr. Riley states that at Fort McLeod vast numbers of the young insects were observed by travelers. (Ninth Report.)

1877.—Mr. J. J. Healy tells us that locusts hatched at Fort McLeod, in British America (latitude 49° 35′, longitude 113° 40′ W.), in February, 1877, the weather then being very warm. As Mr. Healy is familiar with the Rocky Mountain locust, and as they abounded in this region in 1876, we are disposed to think that the above statement refers to this species.

At Bismarck we saw Col. A. S. Sweet, who had that day talked with the Rev. Abbott Martin, of Standing Rock, who had just come from Sitting Bull's camp at Wood Mountain, in British America, sixty miles north of the Montana line, and who stated that there were no locusts seen there up to June 8, the date of his departure.

Manitoba.—The earliest notice of swarms of locusts in this district is to be found in Henry's Journey from Lake Superior to the Pacific Ocean (1799–1816). The following paragraphs were extracted for the use of the commission by Mr. James Campbell, librarian of the library of Parliament:

1800.—Lake Winnepeg, Sunday, August 17, 1800, the beach was covered with grasshoppers which had been thrown up by the waves, and formed one continued line as far as the eye could see. In some places they lay from six to nine inches deep, and now were in a state of putrefaction, which occasioned a horrid stench.

1808.—Pembina River, June 25, 1808. I found great swarms of grasshoppers, which still continue here, and have destroyed the greater part of my vegetables in my kitchen garden; in particular, the onions, cabbage, melons, cucumbers, carrots, parsnips, and beets. They also attacked the potatoes and corn, but these had acquired sufficient strength at the root to resist and sprout up again, whilst plants of a weaker nature had been destroyed. These swarms of grasshoppers appear about the 15th of June. They generally come in great clouds from the southward, and spread destruction wherever they pass; even the very trees were stripped of their leaves. They pass on northward until millions are drowned in Lake Winnepeg, and cause a most horrid stench, as I have already observed.

The locust-years in Manitoba, or that portion of British North America lying between longitude 95° and 102° W., according to Mr. G. M. Dawson, were the following: 1818, winged locusts; in 1819 the young appeared; from 1820 until 1857 none were noticed; in 1857 locusts arrived, but the source was not stated; in 1858 the progeny of the 1857 swarms were injurious. In 1864 fresh swarms arrived from the west, in July; their progeny were troublesome in 1865. In 1867 swarms appeared in August, and their progeny in 1868. Mr. J. J. Donnelly told me at Fort Benton that in 1871 and 1872 the grasshoppers died in heaps and ridges at Fort Garry. In the year 1872 he said that they flew from Saint Joseph, on Pembina River, northwest toward Fort Garry. In 1872 swarms appeared in August, and their progeny in 1873. In 1874 immense swarms arrived July 17th. In the summer of 1875 the progeny of the 1874 swarm hatched in great numbers over almost the entire area of Manitoba, and westward at least as far as Fort Ellice, on the Assine-

boine River (longitude 101° 20′). In many districts the destruction of crops was well-nigh complete. These broods flew southeast, or south, in July and early August, flying into a country of thick woods, swamps, and lakes.

Foreign swarms from the south crossed the forty-ninth parallel with a wide front stretching from the ninety-eighth to the one hundred and eighth meridian, and are quite distinguishable from those produced in the country from the fact that many of them arrived before the latter were mature. These flights constituted the extreme northern part of the army returning northward and northwestward from the States ravaged in the autumn of 1874. They appeared at Fort Ellice on the 13th of June and at Qu'Appelle Fort on the 17th of the same month, favored much, no doubt, by the steady south and southeast winds, which, according to the meteorological register at Winnepeg, prevailed on the 12th of June and for about a week thereafter. After their first appearance, however, their subsequent progress seems to have been comparatively slow and their advancing border very irregular in outline. They are said to have reached Swan Lake House, the most northern point to which they are known to have attained, about July 10, while Fort Pelly, farther west, and nearly a degree farther south, was reached July 30, and about seven days were occupied in the journey thence to Swan River Barracks, a distance of only 10 miles. It is more than probable that the first southern swarms were followed by others, which mingled with them, or even, in parts of Manitoba and the country immediately west of it, with the indigenous brood. From a few localities only in Manitoba, and those in its western portion, is the evidence pretty conclusive as to the arrival of foreign swarms from the south. Burnside, Westbourne, Portage la Prairie, Rockwood, and Pigeon Lake may be mentioned as affording instances.

Many of the grasshoppers observed, according to reports received by Mr. Riley, in Dakota, at Fort Thompson, Yankton, Fort Sully, Springfield, Fort Randall, and Bismarck flying northward and northwestward at various dates in June and July, no doubt eventually found their way north of the forty-ninth parallel. Those seen at Bismarck about June 6 and 7 probably belonged to the earliest southern bands above referred to, and, judging from the dates given by Mr. Riley, may have been produced in Nebraska, or more probably even still farther south. A portion of the southern and eastern army probably reached Montana, and may even have penetrated in diminished numbers into the districts in the vicinity of Bow River.

A considerable number of locusts appear to have hatched at about the same date as in Manitoba near the extreme western margin of the plains, especially in the country near Bow River. Foreign swarms arrived at Fort McLeod from the southwest, depositing eggs; and most of those hatching near Bow River, and farther north, seem to have gone southeastward early in August. No very definite or wide-spread movement of swarms appears, however, to have occurred during the summer of 1875 in this region, nor, if we may judge from the very meager accounts received, in the corresponding portion of Montana.

During the summer of 1875, the conditions described in the Notes for 1874 as occurring in the region west of the one hundred and third meridian were reproduced in Manitoba, and over a great area of the Western and Southwestern States, with results even more disastrous to the crops than those of the winged invasion of the previous year. We do not hear of any access of fresh swarms to Manitoba from the west or northwest, nor is it probable that any such occurred, notwithstanding the fact that in various parts of the province flights are reported to have passed over from northwest to southeast. From the dates and descriptions given, it seems certain that these were only those from the more remote parts of the province itself, and in many cases the broods hatched in any locality mingled with those coming from a little distance, and departed at the same time.

The most remarkable and exceptional feature in connection with the appearance of

the locusts in 1875 is the extensive invasion of the wooded region east of Manitoba by the swarms produced in the province. This is the more noticeable when contrasted with the immunity enjoyed by Prince Albert on the Saskatchewan, alluded to in last year's Notes, which is owing to its separation from the general area of the plains by a belt of timber. On writing to Mr. Clarke, of Carleton House, on the subject, he informs me that this protecting belt of fir-timber is only four miles in width, and extends completely across between the north and south branches of the Saskatchewan. Judging from the above remarkable fact, and the known habits of the locust, I do not think that the incursion made into the forest-country can be looked upon as anything but exceptional, and perhaps showing that the locusts had lost their reckoning. Nor do I believe that it should discourage the cultivation of belts of woodland, which promises to effect in time a general and permanent amelioration of the grasshopper plague.

Broadly sketched, the movements of the locusts in 1875 conform to a general plan. All those hatching in Minnesota, Manitoba, Northern Dakota, and in the high western region of the plains, at least as far south as Colorado, on obtaining their wings, went southward, and this in some instances regardless of the direction from which their parents had arrived in the previous year. Swarms produced in Nebraska, Missouri, Kansas, Texas, and Indian Territory flew northward and northwestward, returning on the course of their parents, which had flown southeastward from that quarter. This movement can be traced over an immense area, from the northern borders of Texas almost to the Saskatchewan River.

Evidence appears to be fast accumulating to show that the general and normal direction of flight for any brood is to return toward the hatching-grounds from which their parents came, and it would seem that to complete the migration-cycle of the locust two years are required. The tendency which the swarms show to migrate on reaching maturity cannot be wondered at, as it is so commonly met with in other animals, and may be assisted by the mere lack of food in the district which has for a long time supported the young locusts. The fact, however—let us call it instinct or knowledge—that the young, while amenable to the migratory tendency, show a determination to exercise it in a direction exactly opposite to the preceding generation is most remarkable. (Dawson.)

1876.—Professor Dawson writes us that, "during the summer of 1876, the grasshopper was scarcely seen in Manitoba, and a fine crop was harvested all over the province. Manitoba is safe for next summer, unless *invaded*. I have reason to believe, however, that during last summer the locust was very abundant in the far West, on the plains east of the Rocky Mountains, and north of the forty-ninth parallel. With regard to this region, however, I have only general information." (Packard's Report for 1875.)

In Mr. G. M. Dawson's notes on the locust in the northwest in 1876, (Canadian Naturalist, vol. viii, No. 7,) it is stated that July 26th large swarms were seen east of the Little Saskatchewan; they afterward flew southward into the United States. A little west of Winnepeg the young had just hatched, June 19th. On July 16th they were drifting past Fort Ellice, in clouds, to the southeastward, and they were observed flying August 4th–11th, at a place about 40 miles northwest of Ellice. "No grasshoppers seen on the way from Ellice to Battleford in August, though abundant in this region of country during July. Very abundant toward the foot of the Rocky Mountains and in the whole upper part of the South Saskatchewan Valley, where they are said to have eaten up all the grass, driving the buffalo eastward to the vicinity

of the Touchwood Hills, Souris Valley, etc. They did not appear at Fort Galgarry, Bar River, N. W. T., in the summer of 1876, but were reported as abundant on the plains to the eastward. From Fort Walsh, N. W. T., they hatched about the middle of May, and remained until the middle of August, when they flew northwestward. Other swarms arrived on the wing from Montana about the middle of July, and passed on to the northwest without leaving eggs. At Fort Pitt there were no grasshoppers within a distance of 300 miles west. Locusts were observed in hugh swarms 150 miles south of Carleton Home. At Swan River Barracks and Livingston they hatched and remained till August 7th, when they flew northeastward. Flights from the southwest arrived about June 2d and also July 20th and 27th, and August 8th. All the crops were destroyed. For twelve years before July, 1875, no grasshoppers had been seen there. The young hatched northwest of Lake Manitoba and at Manitoba House about June 1st. At Oak Point, Lake Manitoba, locust were seen flying southeastward, and the dead were washed up in meadows a foot thick on the shore of the lake.

In 1877 Mr. Riley ascertained that there were very few specimens to be found in Manitoba, as he only met with a few stragglers. Capt. Stewart Moore, of Prince Albert Mission, who had just come from Edmonton, Northwest Territory, reported them as flying from the south early in July, as far northwest as the vicinity of Battle River; Mr. A. Fuller reported them as occurring some distance north of Fort Carleton; Mr. W. J. Scott, of Battleford, who traveled from this place to Winnepeg, in June, found no locusts in the country, thus making the presumption strong that the later flights observed came from farther south.

TABULAR VIEW OF LOCUST-YEARS.

Following is a tabular view of the years in which the Rocky-Mountain locust has appeared, from the earliest date known, up to and including the year 1877.

As may be seen by reference to the foregoing data, in most of these years the actual loss to crops was more or less slight. The years in which losses were sustained by the young hatching in the spring, and in which there were afterward in that season no invasions, are starred. The years in which more or less severe damage was done are in full-faced type.

It is evident that the apparent increase in the number of locust-years, after and including 1866, is due to the larger population of the West, and to the fact that there were greater facilities for travel, so that definite information could more readily be obtained. There are no facts tending to show that the locusts themselves have been any more numerous of late years than previous to, for example, the years 1866 and 1867.

Tabular view of locust (C. spretus) years.

Texas.	Arkansas.	Indian Ter.	Missouri.	Kansas.	Nebraska.	Iowa.	Minnesota.	Dakota.	Montana.	Idaho.	Wyoming.	Colorado.	Utah.	New Mexico.	Arizona.	Nevada.	Washington T. and Oregon.	British North America.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1800
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1808
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1818
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	*1819
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

CHAPTER III.

STATISTICS OF LOSSES.

The subject of this chapter is so intimately connected with that of the following that it may in fact be considered a part of it; for nothing can be presented which will show in a stronger light the blighting effect of locust visitations upon the agriculture of the West than the immense loss these cause. But in order to present the subject in as clear a light as possible, it has been thought best by the commission to devote a special chapter to it. As will be seen by an inspection of the figures here given, the losses experienced in the border States have been very heavy; indeed, we should not be using too strong language if we were to say they are startling. Although we were satisfied from previous examination of the subject that they were large, we have been somewhat surprised at the figures which a careful collation of the statistics bring out. Large as the figures show the direct loss to the crops to be, they fall far short of representing the entire loss occasioned by the locusts. The check to business, improvements, and the various industrial enterprises; the effect these visitations have of stopping immigration and driving away capital, bring upon these new States a greater loss than that sustained by the crops. A full statement of the subject should therefore include all the losses occasioned by these things, but this can scarcely be reduced to figures or ascertained in dollars and cents; hence our only method of conveying a correct idea in reference thereto is to introduce statements from those who have had experience in the locust-ravaged districts during such visitations.

On account of the great difficulty of obtaining reliable data, where no special arrangement has been made for this purpose—as is generally the case—it is impossible to do more than make an approximate estimate of the actual loss sustained; still we believe what we here give may be relied upon as probably as nearly correct as statistics in reference to crops and agricultural products usually are. In Minnesota some attempts have been made to gather statistics in reference to the portion and value of the crops destroyed in that State since 1873; but with this exception we are not aware that any effort has been made in any of the visited States or Territories to obtain such statistics.

We have, therefore, within our reach but two methods by which we may arrive at an approximately correct estimate of these losses. First by combining the local estimates of the loss so far as they have been given, and using the per cent. thus obtained as a basis of calculation. But the result of such a calculation would after all be but little better than a guess and of no real value. Instead, therefore, of attempting to ascertain the aggregate by this method, we will present the statements of

local observers showing the ravages of the locusts in their respective sections, which will convey a more vivid and clear idea of the suffering and distress occasioned by these calamitous visitations than can possibly be obtained from a mere inspection of statistics and figures. The estimate of the losses will be made by the second method, which consists in comparing the yield of a locust year with that of a year when there was no locust visitation, as, for example, 1874 with 1875, and eliminating as far as possible all losses occasioned by other causes.

Most of our readers will remember very distinctly the reports of destitution and suffering in the border States in 1874, occasioned by the destruction of the crops in these States by the grasshoppers. It was felt to be a national calamity, which called for assistance from the benevolent and sympathizing throughout our country. So great, in fact, was the calamity and so urgent the necessity for some action that the legislatures of some of these States were convened in extra session for the purpose of providing some means of relief.

Although it is now apparent that much that was unwise and derogatory to the best interests of these States was done by overzealous workers, and that the methods of affording relief were in many cases not the best, yet the universal feeling that relief was needed is evidence of the severe loss sustained by the people in the locust-visited area.

The following extract from the Third Annual Report of the State Board of Agriculture in Kansas will give some idea of the immediate effect of the locust-visitation in that State in 1874:

About the 25th of July, one of those periodic calamitous visitations, to which the trans-Mississippi States are liable once in from eight to ten years, made its appearance in Northern and Northwestern Kansas, the grasshopper or locust. The air was filled and the fields and trees were completely covered with these voracious trespassers. At one time the total destruction of every green thing seemed imminent. Their course was in a southerly and southeasterly direction, and before the close of August the swarming hosts were enveloping the whole State. The visitation was so sudden that the people of the State became panic-stricken. In the western counties, where immigration for the last two years had been very heavy, and where the chief dependence was corn, potatoes, and garden vegetables, the calamity fell with terrible force. Starvation or emigration seemed inevitable unless aid should be furnished. At this critical period the State board of agriculture undertook to collect correct data relating to the effects of the prevailing drought and devastation of crops by locusts and chinch-bugs. In the mean time Governor Osborne had issued his proclamation convening the legislature in extra session on the 15th day of September.

The following replies to the circular sent out by the board of agriculture to the different counties will give an idea of the destruction of crops by the locusts:

Barton County.—"Grasshoppers appeared July 26 and destroyed all the corn and garden vegetables, together with the present year's growth of fruit trees of all kinds."

Brown County.—"Appeared August 15; stripped the corn and nearly destroyed the ear; took all the foliage from fruit trees, and seriously damaged the fruit."

Clay County.—"Made their appearance in different portions of the county from the 25th to the 30th of July. Nearly all green crops were destroyed; fifty per cent. of the fruit crop ruined."

Cloud County.—The most terrible calamity that has ever befallen Northwestern Kan-

sas has just swept over us like the devouring locust of Palestine. The land was as the garden of Eden before them, and behind them a desolate wilderness.

Decatur County.—"Grasshoppers destroyed the corn crop and drought the wheat, oats, barley, and potatoes."

Ellis County.—"Destroyed everything growing except the grasses."

Ellsworth County.—"Destroyed corn and everything green except sorghum and broom corn."

Edwards County.—"Crops entirely destroyed, not one bushel of vegetables or grain being saved for man or beast."

Harvey County.—"Nearly total destruction of corn and vegetables."

Jefferson County.—"Destroyed all corn, fodder, and vegetables; late corn entirely and early corn to a considerable extent. Fruit trees stripped and fruit badly damaged."

Jewell County.—"Destroyed all crops not mature, except sorghum."

Lincoln County.—"Destroyed corn and vegetables."

Lyon County.—"Destroyed all green crops and vegetation."

Marion County.—"Destroyed nearly all the corn and vegetables."

McPherson County.—"Nearly a total destruction of corn and vegetables."

Mitchell County.—"Entire corn crop and vegetables destroyed."

Morris County.—"Corn nearly ruined; vegetables entirely so; fruit and shade trees badly damaged."

Norton County.—"Crops entirely destroyed."

Osborne County.—"Corn crop destroyed; also vegetables, hedges, and young fruit and forest trees."

Ottawa County.—"Entirely destroying the corn crop, vegetables, and fruit."

Pawnee County.—"Total destruction of crops."

Reno County.—"General destruction of late crops"

Republic County.—"Corn crop and vegetables totally destroyed, and fruit trees seriously damaged."

Riley County.—"Destroyed nearly everything green."

Russell County.—"Completely devastated the country."

Rush County.—"We have nothing left but our teams, which we will have to sell or starve unless we receive aid."

Shawnee County.—"Destroyed nearly everything they were capable of destroying."

Smith County.—"Entirely destroyed corn and nearly all kinds of vegetation."

Wabaunsee County.—"All the corn destroyed except some of the earliest which had ripened; vegetables, fruit trees, and this year's growth of trees were also destroyed."

Washington County.—"Almost entire destruction of corn crop, vegetables, and fruits."

We have no such complete returns from counties in the other Western States and Territories as from Kansas, but in a large part of Nebraska, Minnesota, Dakota, and the northwestern section of Iowa, the destruction of crops in 1874 was about the same as Kansas.

Gov. C. K. Davis, of Minnesota, writing to the Secretary of War, says:

"The locusts have devoured every kind of crop in the northwestern part of Minnesota. (They did the same thing last year, in the same area.) Many thousands are now suffering for food, and I am using every public and private source to send immediate supplies of food."

The commissioner of statistics of the same State, in his report for 1874, says that the locusts destroyed more than 50 per cent. of the crops in the following counties: Brown, Clay, Cottonwood, Jackson, Lac qui Parle, Lincoln, Lyon, Martin, Murray, Nobles, Redwood, Renville, Rock, Watonwan, and Yellow Medicine.

The following quotations from the correspondence given in Professor

Riley's eighth report as State entomologist of Missouri present a somewhat vivid picture of the ravages of the locusts in that State in 1875:

"In Saint Joseph the grasshoppers are reported as the sands of the sea, and sweeping everything before them."

Atchison County.—"The locusts are taking everything green as fast as it appears above the ground in this part of the county."

Bates County.—"It is actually alarming and distressing to see all our crops and pastures eaten off until they are as bare as in midwinter." "The grasshoppers have destroyed the country." "There is scarcely a green thing left in the country. All of our crops are destroyed."

Buchanan County.—"I think by the time the hoppers leave here they will have devoured everything green. The crops are about all destroyed now, together with the pastures and meadows. The country would present the appearance of winter were it not for the foliage of the timber. The leaves are all stripped off the hazel bushes."

Cass County.—"Those persons at a distance and out of range of the plague can have but a faint idea of our situation, nor can they comprehend the fearful ravages made by these pests. They have already eaten up the wheat and oats, and are taking the corn that is planted as fast as it appears above the ground. Our gardens and meadows have been totally despoiled, and our once beautiful flower-flecked prairies now look as desolate and barren as the desert. Our stock will either have to be sent off or starve, as there is nothing for them to eat. The influence of the plague is being severely felt in our cities and towns by all classes. Business is becoming stagnated, work of all kinds is on the decline, and gloom and despondency fill almost every heart."

Clinton County.—"All the meadows, both clover and timothy are absolutely destroyed, and nothing but frequent and heavy rains will save the blue grass. The devastation is much heavier and more universal on the west and south sides of the county. The hazel and undergrowth are leafless as in winter; all the small fruits of every description are destroyed."

Gentry County.—They ate all the wheat that was on high land, also, oats and corn; all garden vegetables and a great portion of the fruit. Imagine every green thing on the face of the earth eaten entirely up, the meadows and blue grass pastures as bare of vegetation as the center of a State road that is traveled a great deal, and you can probably form some idea of our condition at the time.

Henry County.—"The locusts have already destroyed a large portion of the crops in sections of this county, and still continue their work of devastation. The western and northern part is almost a desert, there being scarcely a vestige of *anything* green remaining to be seen."

Jackson County.—"Pastures have been stripped of foliage, oat, and wheat fields have been swept, gardens are bare of any growing vegetable, and the corn-fields are alike destitute of any indications that anything has been planted. The small fruits are irrevocably gone, and the larger fruits are now becoming a prey to their devouring powers. They swarm into the houses, hopping and climbing in every place that is not absolutely closed against them."

Saint Clair County.—"The grasshoppers have eaten up all the flax, all the wheat, and corn, and now are attacking everything green even grass, and three weeks hence will witness a country as barren as the grim deserts of Africa."

We could multiply quotations and extracts from various sources, and from our own correspondence the past season, but these will suffice to convey an idea of the terrible havoc this insect scourge inflicts upon the farmers of a district which it invades in full force. We give them for this purpose as no amount of statistics and figures would ever convey a correct idea of the sufferings of a locust-ravaged pioneer settlement.

The statements from our own correspondents will be found in Appendix 20.

In order to arrive at something like a correct estimate of the absolute loss to crops by locust ravages we have concluded to take the chief crop—corn—in the four States, Kansas, Nebraska, Missouri, and Iowa, in the years 1874 and 1875, the first a locust year, the second a full crop year, as a basis. We select these States because they are known to have suffered severely in 1874, and for the reason that the statistics of their crops are given in the annual reports of the Department of Agriculture without any special reference to the point now under consideration and hence are free from any suspicion of a disposition to exaggerate the losses.

Loss on the corn crop in Kansas, Nebraska, Iowa, and Missouri in 1874, *as shown by reference to the statistical tables in the reports of the Agricultural Department for* 1874 *and* 1875.

Although it is true, as a general rule, that in these western States each year's crop shows an increase over that of the previous year on account of the increased acreage, yet in this case, a comparison of the crop of 1874 with that of 1875 will not lead us into any great error on this account, as the severe shock received by agriculture in these States in 1874 could not easily be ovecome in a single season, moreover, considerable loss was also occasioned by the locusts in 1875; in fact, the wheat crop of 1874 was fully equal to that of 1875, because the former was generally harvested before the locusts arrived, while the latter was seriously injured by the young insects.

We are fully aware of the fact that 1874 was a very dry year and that crops throughout the whole country suffered very materially from this cause, and that on this account the difference between the crop of 1874 and 1875 cannot all be attributed to the locusts, in those States visited by them. But, as will be seen by the statistics which follow, we have endeavored to eliminate from the estimate the proportion of the loss attributable to the dry season. To do this correctly we have had to make a special case of Illinois from the fact that it has been shown by estimates from two entirely different sets of data that the loss on corn in this State in 1874 by the chinch-bug was, at least, equal to 32 per cent. of the crop of 1875.

Departments' estimate of the corn-crops of 1874 *and* 1875.

	1874.	1875.
	Bushels.	*Bushels.*
Iowa	115, 720, 000	160, 000, 000
Missouri	46, 049, 000	128, 000, 000
Kansas	16, 065, 000	76, 700, 000
Nebraska	3, 500, 000	28, 000, 000
Total	181, 324, 000	392, 700, 000 181, 334, 000
Aggregate loss on corn in these States		211, 366, 000

Taking the crop of 1875 as a basis this shows a loss of 53.8 per cent. occasioned by locusts and drought.

If we now take the loss on this crop in all the other States (except Illinois) as representing the per cent. of loss occasioned by the dry weather, and deduct this per cent. from the per cent. of loss in the above named Western States, we may fairly consider the remainder as that caused by the locusts.

The total crop of corn in the United States in 1874 and 1875, as given by the department reports, were as follows:

	1874.	1875.
	Bushels.	*Bushels.*
United States	850, 148, 500	1, 321, 069, 000
Deduct crops of the States mentioned and Illinois	314, 913, 000	672, 700, 000
Aggregate of the other States	535, 235, 500	648, 369, 000
		535, 235, 500
Aggregate loss on corn in all the other States		113, 133, 500

Taking the crop of 1875 as a basis, this shows a loss of 17.4 per cent. Deducting this from the 53.8 per cent. loss in the Western States named it gives 36.4 per cent. as the portion lost, which is attributable to the locust visitation in 1874. Taking 36.4 per cent. of 392,700,000 bushels, the total corn crop of these States in 1875, it gives 142,942,800 bushels as the aggregate loss by the locusts. Estimating this at 28 cents per bushels, the average price for these Western States, as given in the report for 1875, and we have a money loss of 40,023,984 dollars, or in round numbers, forty millions of dollars on the corn-crop alone in a single year in four Western States.

Lest this may be considered as an unfair method of arriving at the correct loss, as it does not take into consideration the difference in acreage, let us see what it amounts to by this method.

The total acreage in corn in these four States in 1874, according to the department report for that year, was 8,721,076, the average yield of corn per acre in these States in 1875 was 37.9 bushels, in 1874 it was 16.4 bushels, showing a difference of 21.5 bushels per acre. The proportion of loss by the locusts was 36.4 per cent. out of 53.8 per cent. or about 68 per cent. of the whole loss. A loss of 21.5 bushels per acre on 8,721,076 acres gives an aggregate of 187,503,134 bushels; 68 per cent. of this is 127,502,133 bushels. At 28 cents this gives a money loss of 35,600,597 dollars, the two results differing only about 11 per cent.

Minnesota and Texas are omitted from these estimates because this crop was fully as large in these States in 1874 as in 1875, and the loss in the former in 1875 from locusts and cold season was greater than in 1874.

The loss on wheat in 1874 was generally less than in 1875 as it was mostly harvested when the locusts arrived in the former year, and suffered from the young in the latter. This to a large extent was also the

case with other small grains. The loss on the potato crop, however, was heavy as appears from the following exhibit taken from the same reports heretofore referred to:

	Crop of 1874.	Crop of 1875.	Loss.
	Bushels.	*Bushels.*	*Bushels.*
Iowa	4, 806, 000	8, 700, 000	3, 894, 000
Missouri	2, 022, 000	6, 300, 000	4, 278, 000
Kansas	1, 116, 000	4, 480, 000	3, 364, 000
Nebraska	275, 000	1, 950, 000	1, 675, 000
Aggregate	8, 219, 000	21, 430, 000	13, 211, 000

The loss in those States as shown by these figures amounts to 13,211,000 bushels, worth according to the average price in this section in 1875 (27 cents), $3,556,970; 68 per cent. of which is $2,418,739.

In Minnesota the difference in the potato crops of the two years was a little over 2,000,000, of bushels.

The loss sustained by the destruction of gardens, which suffer more perhaps in proportion to their value than anything else, when aggregated amounts to a much larger sum than would be supposed. As bearing upon this point and sustaining this view, we present the following ingenious method of arriving at the loss by the destruction of gardens in the locust-visited counties in Texas in 1877, as given by Serg. C. A. Smith, Signal-Service officer at Galveston:

From the preceding, which I take as fair examples of the remaining devastated counties, I conclude that the damage to the grain crops in the 64 counties visited cannot exceed 5 per cent. Gardens everywhere appear to have suffered to a much greater extent than the grain crops. They were reported as having been entirely destroyed in a large number of cases, and were badly damaged wherever visited. Assuming that a large percentage recovered from the ravages of the insects as in the case of the grain, I will estimate 25 per cent. as totally lost. Taking the population of the 64 counties for the year 1870 as a basis, and dividing it by five to get the approximate number of families, and we have for the latter 84,304; assuming that one-half of these families have gardens worth $75 each, that an average of 25 per cent. were destroyed, and we have $790,350 as the approximate damage to gardens.

Extend this method of estimating this item of loss to all the other States and Territories visited by the locusts in 1874 or 1877, and it will readily be seen that the aggregate amount is very far from being an insignificant sum; nor can we consider the calculation an exaggerated one.

Applying the same method of calculation to the visited portion of Missouri, Iowa, Minnesota, Dakota, Nebraska, and Kansas, and including that for Texas, we have a loss on gardens alone in 1877 of a little over $4,000,000.

Let us suppose that the loss on other crops (except potatoes), gardens, orchards, stock that died from want of food, &c., amounted to but one-half the loss on the corn crop; this would be, taking the lower estimate on corn as heretofore given, something over $11,800,000. Adding together these three items—

Loss on corn	$35,600,597
Loss on potatoes	2,418,739
Loss on other crops	17,800,000
	55,819,336

and we have an aggregate loss in the four States mentioned, for the year 1874, by the locusts, of about $56,000,000.

This estimate we believe is fully sustained by the facts, and if erroneous, it is not because the losses are exaggerated, but for the reason that they are understated. It is certainly much less than any made from local estimates.

But the actual amount destroyed by the locusts does not give the absolute financial loss to the people of these States. All over and above what is necessary for home consumption changes hands or form, and with each change increases in value. In other words, every dollar's worth of corn thrown into market or converted, by the time it or its resultant leaves the State, has at least doubled in value. Not that the actual price or value of a bushel of corn is doubled, but that the labor, business, trade, &c., it has put in motion has resulted in adding the value of another bushel to the material wealth of the State, and perhaps if we were to say of two bushels, we should not be beyond the fact. The farmers themselves scarcely felt the effect of these losses financially more than the business men and mechanics of these States, and we think it no exaggeration to say that the absolute financial loss by this secondary effect was fully equal to the direct loss on crops; perhaps even more. If the depreciation in the price of real estate be taken into consideration it was certainly more, but as this will be recovered when the cause of alarm passes away, we have thought best to omit it entirely from the estimate.

Calculating in this way, we see that the actual loss to these four States in a single year by this terrible scourge amounted to at least $100,000,000.

The loss in Minnesota for this year, although severely felt by the farmers of the western counties, is comparatively small when considered with reference to the production of the whole State. It was estimated by the commissioner of statistics for that State as follows:

On wheat	$2,000,000
Oats	518,000
Corn	256,000
Other crops	250,000
Total	3,034,000

We have no satisfactory statements of losses in any of the other States or Territories for this year, and hence can only guess at them from the very imperfect data we have been able to obtain from published reports and our own correspondents during the past year. The following statements and estimates in reference to the losses in other years

will afford some assistance in making up a general estimate of the amount sustained during the years 1874–1877:

Statistics of losses in Minnesota occasioned by locusts in the years 1875 *and* 1876, *as shown by the report of the commissioner of statistics of that State.*

	1875.	1876.
	Bushels.	*Bushels.*
Wheat	2,024,972	3,315,240
Oats	1,127,780	2,251,374
Corn	790,981	1,305,169
Barley	41,059	159,368
Rye	1,131	.....
Buckwheat	16,450	.....
Potatoes	130,886	.....
Beans	7,971	.....
Total	4,141,230	7,031,151

Mr. Riley, in his eighth annual report as State entomologist of Missouri, from the data he was able to collect, estimates the loss occasioned by the locusts in the counties of Western Missouri, in 1875, on grains alone, as follows:

Atchison, $700,000; Andrew, $500,000; Bates, $200,000; Barton, $5,000; Benton, $5,000; Buchanan, $2,000,000; Caldwell, $10,000; Cass, $2,000,000; Clay, $800,000; Clinton, $600,000; DeKalb, $200,000; Gentry, $400,000; Harrison, $10,000; Henry, $800,000; Holt, $300,000; Jackson, $2,500,000; Jasper, $5,000; Johnson, $1,000,000; Lafayette, $2,000,000; Newton, $5,000; Pettis, $50,000; Platte, $500,000; Ray, $75,000; Saint Clair, $250,000; Vernon, $75,000; Worth, $10,000. Amounting in the aggregate to something over $15,000,000.

We have no satisfactory statements of losses in any of the other States or Territories, for this or either of the subsequent years, nor have we any data by which to estimate the aggregate losses for either of the years 1874, 1875, 1876, or 1877, in Colorado, Montana, Dakota, or Utah. But it is fair to presume that in the entire locust-visited area, during these years, the total loss would fall but little, if any, short of $200,000,000. If this had been distributed over a number of the thickly-settled States, its effect upon the industries of these States would have been but slightly felt; but when we remember that it was borne almost entirely by Minnesota, the western half of Iowa, the western section of Missouri, Nebraska, Kansas, the western part of Texas, and some of the sparsely-settled Territories, containing a pioneer population, generally of small means, we can better appreciate the immense suffering it must have entailed and the severe shock given thereby to the agriculture of the West.

CHAPTER IV.

AGRICULTURAL BEARING OF THE LOCUST PROBLEM.

This particular aspect of the "locust problem" is the one of most importance to the people at large, to the citizens of the infested districts, and to our national authorities; it is also, doubtless, the one in which Congress feels the most interest; in fact, it embraces the chief object for which the commission was created. Here we are expected to meet and answer the questions, What has been and what is likely to be the effect of locust visitations upon the agricultural development of the great West? It is not difficult to answer the first of these questions. This has already been done, in part, in the foregoing chapter, but will be further considered in a more general manner in this. But the second is the one in reference to which there is most anxiety, and in regard to which the people and our national authorities are most desirous of obtaining information.

We will therefore consider these questions briefly in the order given, but, at the same time, desire that it be understood we cannot undertake to answer fully the second until we have completed our investigations, as there are some important links in the history of these insects which are yet in obscurity.

The direct injury to the agricultural districts of the West is somewhat fully shown in the preceding chapter. The manner in which an injury is inflicted often has a much more disastrous or paralyzing effect than the injury itself. Ten per cent. loss on the wheat or corn crop of a State, if caused by excessive rains or dry weather, or, if it be the result of some secret insect foe, as the wire-worm, grub-worm, or chinch-bug, will excite no alarm; but, if an invading swarm of locusts swoop down suddenly and unexpectedly upon an agricultural district and in a few hours destroy one field in ten, a feeling of alarm at once takes hold of the entire farming community, and the paralyzing effect is far greater than if twice the amount had been destroyed by some slow and more usual process. If this is repeated for two, three, or four years in succession the discouraging effect is increased in like ratio. But, if instead of a loss of ten per cent. an entire crop is destroyed, a feeling of alarm takes hold not only of the farmers but of the entire population of the visited area, especially if it be a newly-settled district, as our Western States and Territories. In oriental countries, where the people have long been accustomed to such visitations and have learned to expect them, the paralyzing effect, as a matter of course, is not so great; but our western districts are occupied by a population heretofore unaccustomed to such injuries, and hence the shock which the agriculture of those sections

receives is much greater than it would be if, by long experience, the people had become accustomed to such visitations.

The struggling pioneer who has managed, with his limited means and with no force but himself and family, to break the sod of a forty-acre tract and plant his corn, and then sees it swept away in a single day by a swarm of hungry locusts, is necessarily greatly discouraged. If this is repeated for two or three years in succession, or even in the course of a few years, he is forced to give up the contest and seek a home in some other section.

Hundreds and thousands of exactly such cases as this were to be found in the border States during the series of locust visitations which occurred between 1873 and 1877. The tales of their hardships told in letters sent back to their friends had their effect, and for a time the tide of emigration not only ceased but turned back, and hundreds, perhaps thousands, of homes were left untenanted, and fields uncultivated. Nor is it strange that such should be the case; the only wonder is that, under the circumstances, so many continued to struggle so long and so bravely.

As a natural consequence, business of all kinds was in a great degree suspended, improvements stopped, and the development of the country checked. Although rich in material and life-sustaining resources, and abounding in fertility and productive forces, they were in a great degree negatived or rendered valueless for these four years by the visitations of an insect scarcely more than an inch in length. So widespread was the devastation and so severe the scourge that State and national aid was deemed necessary to assist in staying it. As a result of this feeling the legislatures of some of the western States were convened, and the meeting of governors at Omaha, heretofore mentioned, was called. The following extract from Governor Pillsbury's address at the Omaha meeting sets forth in strong colors the distress and uneasiness we have alluded to:

I shall not attempt any details of the prolonged visitation of the destructive insects, from which several States are now suffering. Most of you are doubtless familiar with the sad experience of many localities in your several States, where the people have suffered continuously, to the last extremity of endurance. In my own State the ravages have thus far been confined to a comparatively small belt along our western and northern borders, but within this area many localities have suffered an almost total loss of crops for four years in succession, and with these people the question is fast assuming the vital alternative of exterminating the pests, or being exterminated by them.

The following brief extracts from the committee report, resolutions, &c., of that meeting indicate the general feeling and views of those present on this point:

The Rocky Mountain locust, or grasshopper, by its migrations from Territory to Territory and from State to State, destroying millions of dollars' worth of the hard earnings of the western farmers, crippling the progress of the border States, and retarding the settlement of the Territories, has become a national plague. Its injuries are of such magnitude that no effort should be left untried that will be likely to diminish or avert them. (From committee report.)

The scourge of the grasshoppers or locusts has become so alarming, during the last two years, as to seriously threaten the prosperity of many of the States and Territories. (From Governor Pennington's resolution.)

These facts, together with the statement of the losses sustained as given in the previous chapter, make it evident that the locust visitations in these States and Territories have been a serious drawback upon the agricultural progress of the West.

WHAT IS LIKELY TO BE THE EFFECT IN THE FUTURE.

The favorable result of the agricultural operations last season, brought about in great part by the character of the weather, but in part by the determination with which the farmers contended with their insect foes, has to a great extent restored confidence. Emigration has again set in, and the older residents having learned by experience means of protecting their crops against the ravages of the young locusts, now feel themselves more able to cope with the difficulty than formerly. Yet a repetition of the invasions so recently ended, unless long deferred, would be a severe blow to the agriculture of these western sections, and would cause those seeking new homes to hesitate long before running the risk of having the results of their toil and labor destroyed by this severe scourge.

We firmly believe, as we have again and again asserted, and which so far the facts seem to bear out, that the locusts can never become permanent residents of the border States; that the long series of visitations so recently ended was unusual and is not likely to be repeated for a long time, most probably not in the present century. Our belief, as a matter of course, is based upon the evidence furnished by the past and not upon any prophetic knowledge of the future. If we could foretell the character of the seasons for these coming years, we could then predict with more certainty the movements of the locusts. If there is a succession of dry years like those recently passed we may look for a recurrence of invasions.

A knowledge of the history and habits of the species has a tendency to remove much of the alarm they excite, and when the past season closed without fresh swarms from the native breeding grounds, thus verifying our predictions, and the people saw that the series of visitations had come to an end, there was a very evident feeling of relief; not only because of a crop saved, but because it was an evidence that the locusts had not become permanent residents.

The benefit arising from the appointment of this commission was experienced more immediately and palpably in this connection than any other. Although the object for which it was authorized was to investigate the history and habits of the locusts and suggest such remedies as would be most effectual in counteracting them, yet the members felt it incumbent upon them to devote attention first to the immediate danger

apprehended from the young insects, and so far as possible to allay the fear and apprehension of invading swarms. And they feel warranted in saying that in this respect their efforts were crowned with more favorable results than could have been expected.

The relation of the locust problem to the condition of the country as to humidity or aridity is so intimate that it cannot be thoroughly understood without a knowledge of the latter, nor is it likely that a complete solution will ever be found so long as the arid condition of a large portion of the West remains as it is.

The migratory habit of locusts, whether in the Eastern or Western Continent, is now known to be directly or indirectly attributable to the arid condition of the area in which they originate. It is only in broad and extensive and comparatively barren regions that we find them perpetuating their race and maintaining their migratory habits. Such areas form the great hives in which they multiply and from which they pour forth the vast hordes that fall upon the more fertile surrounding districts. This fact has been known and understood for ages past; and numerous facts, gathered in recent years, show that where man by his folly has converted fertile districts into barren areas, these, likewise, become the home and prolific hives of the migratory locust.

As is shown elsewhere, the eastern limit of the movements of our migratory species is along the eastern line of Minnesota, middle line of Iowa, and western border of Missouri; but if from any cause these States should ever become as arid as the plains lying west of them, then the locust-swarms will be seen moving eastward across the Mississippi in search of more fertile fields. It is evident, therefore, that the final and complete solution of the locust problem depends to a certain extent upon the possibility of modifying, to some degree at least, the aridity of the great plains of the Northwest, which undoubtedly form the native breeding-grounds of these insects.

By most persons this will be considered equivalent to saying that the locust problem will never be solved. It would scarcely be proper for us here to enter into a discussion of the question of the possibility of modifying the condition of the dry area, but we cannot refrain from placing upon record our protest against any such conclusion as this. That man, with a mind that can bring art, science, and mechanics to the perfection now visible on every hand, must be forever unable to convert the desert into fertile fields, or to redeem the waste places of earth, we cannot believe, unless we are shown that the moisture which once supplied these areas has forever taken its departure from our globe.

To what extent these dry areas of the West can be supplied with water and rendered fertile must be determined by those who are proficient in this particular branch of science; but, that large sections can be redeemed by proper efforts, if made on a scale of sufficient magnitude, we have no doubt.

By utilizing all the water that flows down from the mountains for the

purposes of irrigation; by collecting in reservoirs the winter supply and distributing it in the growing season, a very large section of these plains might be brought under cultivation, and extensive forests grown where now the surface is naked and barren. Every field brought into cultivation, every grove planted, and every square yard added to the water surface of these dry regions, is just so far a step toward the ultimate solution of the locust problem; and the nearer these can be brought to their native home the more effectual will they be in rooting them out. If extensive efforts in this direction were made in British America, north of Montana, also in Eastern Montana, Western Dakota, and the regions around the Black Hills, it would not only be of immense benefit in supplying new agricultural fields for emigrants from Northern Europe, but would be a great step toward the final solution of the locust problem. It would also be a most effectual method of settling the Indian question in this region. Just what can be done in the way of redeeming these areas we cannot say, but when their settlement depends upon it, and the welfare of a much larger area south and west also depends upon it, certainly the question is worthy of consideration by our national authorities.

The day is not far distant when our national government will be compelled to meet this important question and to test the ability of man to accomplish the work.

The progress of settlement westward must necessarily be slow when it, as is now beginning to be the case, impinges upon the sterile area; it can only push onward when the front line is backed by a dense population and farms studded with groves. It is possible that if there were no other impediments to overcome than this sterility, formidable as it is, the gradual filling up of the border area with an active population would modify the conditions sufficiently, at least, to allow the pushing into and redemption of a belt of considerable breadth. But when to this difficulty is added the devouring locust the hope of success is greatly diminished.

It requires no high degree of scientific attainments or profound knowledge of physical laws to arrive at a conclusion in reference to the point we are discussing. If the conditions remain as they are, and the locusts are not annihilated they will continue to reproduce and migrate. As the arable areas of the West will soon become absolutely necessary for our rapidly growing population, it follows that without some modifying influence in one or the other of these directions, toward a change of conditions or toward annihilation, there is no hope but for a continual warfare on the part of the western farmers with these insect foes. Learning the history and habits of the species will do much good in the way of enabling the agriculturist to contend to much better advantage; to take advantage of every favorable influence and to be far more successful in defending his crops than he could possibly be without this knowledge. It will also enable him to so modify his

method as to reduce the loss and the cost and labor of defending his crops to a minimum. It will, in a great measure, do away with that feeling of alarm the locusts usually inspire. But still the warfare will go on indefinitely. While it is almost certain that, on account of the wide-spread area of the West in which the migratory species appears to be indigenous, including in its bounds a large extent of mountain country, it will be impossible by any practicable means to utterly exterminate it, yet there are strong grounds for believing that a complete knowledge of its history, habits, and habitats will render it possible to prevent, in a great measure, its disastrous incursions into the Mississippi Valley.

We may say truly that one step has been accomplished, for the experience of last season has sufficed to convince the farmers and citizens of the locust-visited sections when another contest comes they will be able to defend their crops from the young insects.

We feel justified, therefore, in affirming that, although favorable seasons for their development will in all probability cause their return at irregular periods, they will never cause such alarm in the future as they have in the past; and that, although they may occasionally cause a temporary check to, they never can entirely bar, the agricultural progress of the vast area they lately so fearfully ravaged.

Simply fighting these insects fortunately does not exhaust the remedies in the power of the agriculturists of these sections. The facts ascertained render it quite probable, in fact almost certain, that even should the incursions of the locusts continue to occur in the future, and no means of preventing this be found, a modification in the methods of farming or a change in agricultural operations can be adopted which will render the effect of these invasions comparatively harmless.

As a rule, which has few if any exceptions, the invading swarms do not make their appearance in the Mississippi Valley until the latter part of July or first of August. By this time wheat, barley, and oats have generally reached perfection and been harvested. This fact renders it possible to anticipate these swarms and prevent serious injury by relying chiefly upon these crops when there is reason to fear their incursions.

If the hatching grounds from which these swarms usually come can be definitely ascertained, and the national government, by means of the Signal-Service Corps or otherwise, will take measures to give notice in advance of heavy egg-deposits in this area, the farmers, by planting small grains, may thus prevent any serious injury by them when they arrive. This remedial measure applies more particularly to the central and southern sections, as Nebraska and Iowa and southward. In these sections it appears to be also true as a general rule that the young locusts acquire wings and commence migrating sufficiently early in the season to allow corn of rapid growth to be produced after they depart. Hence when the ground is full of eggs and young locusts are expected

in large numbers in the following spring, corn should be relied on as the chief crop.

By adopting this plan of alternating the crops according to the locust status, the injurious effects of both visiting hordes and resulting broods would be very materially lessened.

This plan, as a matter of course, is less applicable in the northern section, where the growing season is shorter and where wheat and small grains come to perfection later in the season. But it is thought by Mr. Taylor, of Manitoba, that by selecting the variety of corn of quickest growth it may be pushed forward to perfection by the time the locusts usually make their appearance. Be this as it may, still it is possible that even here, by a judicious system of cropping, much of the loss which would otherwise be occasioned by these insects may be avoided.

As a general rule the pioneer population of these Western States and Territories consists of individuals of small means who are compelled for the first few years to devote most of their attention to breaking sod, preparing a habitation, and producing food for themselves and stock. Corn is chiefly relied upon, as the seed costs but little, and it affords food for both man and beast, and in the broad timberless sections may also be used for fuel. Wheat is the chief crop by which money can be obtained to purchase clothing and other necessaries which cannot be produced on the farm. It is therefore next to impossible for these persons during the first few years after they settle to alternate their crops. But those who have been longer in the country and have made sufficient headway may do this and thus prevent the general distress occasioned by locust invasions. It would also be wise for those who are in a position that will enable them to do so, to diversify their agricultural operations more than is the custom in these sections. Pease, and the varioust root-crops, such as turnips, potatoes, rutabagas, mangel-wurzel, &c., which answer well for food for stock, are generally less injured than the grains, and should be partially relied upon in years when it is probable the locusts will appear.

The broad prairies of the Northwest are naturally adapted for grazing and seem to be intended for the great wool and beef producing area of that part of the United States east of the Rocky Mountain range; and if this fact were fully appreciated and acted upon as it might be, one great step toward meeting the difficulty would be made. The grasshoppers do but comparatively little injury to the grass, and hence the stock-raisers and herdsmen look with comparative indifference on these visitations. The meat and wool markets are no more likely to be overstocked than the wheat and corn markets, and as the cholera has rendered the raising of hogs an uncertain and precarious business, the meat supply must come chiefly from the pasture of our country. Here, then, is presented one method at least of partially meeting the difficulty.

We present these thoughts, not with a view of urging their adoption exactly as given, but for the purpose of suggesting to the farmers of the West plans by which the difficulty may be in part, at least, overcome,

even should no method of preventing locust invasions be found. These plans, as a matter of course, may have to be modified as experience will show to be necessary; and what is applicable in one section may be unsuited to another—this can only be ascertained by experience.

Among the questions propounded in the circular (No. 1) which we sent out in the early part of the season, were the following:

"No. 12, crops which suffered most."

"No. 14, crops which suffered least."

The answers to these questions, so far as received from Minnesota, Iowa, Nebraska, and Dakota, will be found in Appendix 20. From these it appears that crops which suffered most stand about in the following ratio:

Wheat, 100; barley, 33; oats, 30; corn, 26.

Those which suffered least as follows:

Pease, 100; corn, 53; sorghum, 33; oats, 30; potatoes, 2.

While this method of aggregating the replies may and perhaps does present a generally correct idea as to the comparative injury to crops, the ratio cannot be relied upon for several reasons, among which we may mention the following:

A crop generally grown in one section is seldom grown in another. Some crops are much less common than others, and hence are not so often mentioned in the replies. If we take Minnesota, from which most replies were received, and where wheat and pease are more largely produced in proportion to corn than in either of the other States named, the ratio will stand as follows:

Injured most.—Wheat, 100; oats, 37; barley, 37; corn, 9; flax, 9.

Injured least.—Pease, 100; oats, 38; corn, 31; sorghum, 21; potatoes. 17.

In Nebraska the ratio is as follows:

Injured most.—Wheat, 100; corn, 32; barley, 14.

Injured least.—Corn, 100; sorghum, 66; pease, 33; wheat 33.

It is evident, from all the facts we have obtained, that wheat suffers most from the young insects, to which, as a matter of course, the replies alluded to apply; but that corn suffers most, from the invading swarms, of the field crops.

The replies are evidently intended to apply chiefly to the question of preference in plants shown by young insects. In reference to this point, we may state, as the result of our inquiries and observations, that they are excessively fond of the vegetables grown in gardens; of the field crops they appear to give a decided preference to wheat and barley over corn and oats. As between the last two the testimony is conflicting, but it appears to preponderate to the view that oats are preferred to corn. There appears to be no doubt that pease suffer least of any field crops; sorghum and broom-corn appear to stand next in the list of those least liable to injury. The native prairie grass suffers but little from the attacks either of the young or invading insects, while, on the other hand, cultivated grapes appear to be almost as liable to injury as the small grains.

CHAPTER V.

PERMANENT BREEDING GROUNDS OF THE ROCKY MOUNTAIN LOCUST.

Previous to the year 1877 our knowledge of the extent of the breeding grounds of the Rocky Mountain locust (*Caloptenus spretus*) was vague and unsatisfactory. It was known that the swarms invading the Mississippi Valley mainly came from portions of Wyoming, Montana, and the region in British America lying north of this territory, but to attempt to map out the area and to determine its extent was impossible. From the data obtained, either directly by the Commission or from its correspondents, we are enabled to present a more or less definite statement regarding the extent of the region, and to indicate it upon a map, which, besides showing the geographical distribution of the species and its migrations, indicates the annual or permanent breeding grounds of this locust, its less permanent or subpermanent breeding grounds (Subpermanent Region), and the region only periodically visited, *i. e.*, the Temporary Region.

PERMANENT REGION.

The area in which the locust breeds each year in greater or less numbers is approximately 300,000 square miles; further explorations may increase this area, particularly in Idaho and Montana.

It is not to be inferred that the locust breeds continuously over the whole extent of this area each year, as it is to be understood that the locust within its native, permanent habitat is essentially migratory in its habits, and while for a series of years it may deposit its eggs in a given river valley, in some park, or in some favorable area on the plains lying about the mountains; in a certain year, or for several years in succession, it may desert its customary breeding grounds for adjoining regions, or cross a low range of mountains and breed in a more distant valley. Moreover, the true breeding grounds in this area are for the most part confined to the river bottoms, or sunny slopes of uplands, or to the subalpine grassy areas among the mountains, rather than continuously over the more elevated, dry, bleak plains. For example, over the great range of the plains east of the mountains, where the buffalo grass alone grows, we have no evidence that the larger swarms originate, and where they do, at times, it will be probably found that the locusts hatched in the prairie land bordering the streams intersecting the plains, rather than on the drier, less fertile plains themselves. In Central Montana the breeding grounds are, for example,

known to be situated in the valleys of the Yellowstone, the Upper Missouri, the Sun and Marias Rivers, the Gallatin, Madison, and Jefferson Rivers, and the adjacent grassy plains or prairies bordering their tributaries. All these levels lie below an altitude of 5,000 or 6,000 feet, and usually not over 3,000 to 5,000 feet.

The approximate area in which the locust permanently breeds lies for the most part directly east of the true or main Rocky Mountain Range, the breeding grounds west of the range being comparatively limited. Perhaps one-fourth or one-fifth of the area lies in the lower cañons, parks (old lake basins), and valleys situated among the Rocky Mountains. This area lies mainly between longitude 102° and 114° west of Greenwich and latitude 53° and 40° north.

Such, in general terms, are the limits of the native and permanent breeding-grounds of this locust, and from which the destructive swarms issue in comparatively slight numbers west and south, but in certain years enormous quantities east, to ravage the States lying west of the Mississippi River and east of the Great Plains.

To enter more into detail, and beginning with that portion of British America lying north of Montana, the Commission have no doubt but that all the region lying south of the forest line and south of the 53d parallel of latitude, including the lower half of the valley of the North Saskatchewan as far north as Fort Pitt, is annually inhabited by the Rocky Mountain locust.

In the northwest, the limits do not quite reach Fort Edmonton. On the west, the line follows the eastern flanks of the Rocky Mountains, though it is possible that the western barrier above the 50th parallel of latitude may be the Selkirk Mountains.[18]

The eastern limits of the permanent breeding grounds we may set down approximately as longitude 104°–105° west of Greenwich. The region between this line and the Rocky Mountains is a treeless, elevated plateau, rising gradually from an elevation of about 2,000 feet (Fort Buford is 2,017 feet elevation) to 4,000 or 6,000 feet (Fort Shaw is 6,000 feet, Fort Ellis 4,747 feet, Helena 4,296 feet, Gallatin City 4,132 feet elevation). It is possible that we have drawn the eastern limits of this area too arbitrarily, and that it may follow the line of the Coteau of the Missouri, at least within the limits of Dakota. The northern and eastern limits of the plains are indicated on the map by the line indicating the northern limits of the true prairie land,[19] but there is reason to believe

[18] North of the 49th parallel the Rocky Mountains are now known to extend to the Peace River, and even farther northward, to near the mouth of the MacKenzie, and to maintain throughout much the same geological character with that of their southern portion. The Purcell, Selkirk, Columbia, Caribou and farther north the Omineca Mountains may be taken collectively as the representatives of the Bitter Root Ranges of Idaho. The interior plateau of British Columbia represents the great basin of Utah and Nevada, but north of the southern sources of the Columbia this region is not self-contained as to its drainage, but discharges its waters to the Pacific.—[G. M. Dawson's general note on the mines and minerals of economic value of British Columbia, Geological Survey of Canada, 1877.]

[19] This and the southern limits of the true forests are taken from data published in Palliser's map, and reproduced in a map of the country to be traversed by the Canadian Pacific Railway.—[Sanford Fleming, engineer in chief, 1876.]

that the locust breeds in the belt of land lying between the northern limits of prairie and the southern limits of true forests, also indicated on the map.

This region of the Great Plains extends southward, embracing the area drained by the Missouri River and its tributaries and headwaters, west of the 203d meridian, and including the entire Yellowstone Valley except the Belt Mountains and their spurs, the wooded region and mountains about the Yellowstone Lake, and the Wind River Mountains southward, also including the more elevated portion of the plateau from which the Black Mountains rise.

Although the Rocky Mountains, Bitter Root, and Wind River Ranges are excluded partly because we know little of those mountains, which have not been explored by entomologists, yet there are doubtless a good many cañons, river valleys, and parks lying at their base where the locust may locally abound, and from which in years of unusual abundance swarms may pass out to join those originating in the areas where they are known to multiply to an excess.

Of the large area forming over half of the Territory of Idaho, and lying between the Bitter Root Range and the valley of the Snake River, we know nothing whatever. No naturalist, much less entomologist, has explored this region, which is mainly drained by the Salmon River, though there are small settlements scattered through it, such as Lemhi, Florence, Elk City, Millersberg, Oro Fino, and Cœur d'Alene Mission on the north, from whence we have been able to obtain no information whatever as to the presence or absence of the locust. The origin of the swarms of locusts that have in certain years locally devasted the region about Lewiston, Walla Walla, and the Pataha Valley is not certainly known, though we suppose that they have originated in the Snake River Valley, south of latitude 45° 30′, though some of them may have hatched in the Bitter Root Valley, or even in the valleys on the western flanks of the range. There seems good reasons for regarding the entire valley of the Snake River, from near its headwaters near Henry's Lake and the Teton Range to a little below the mouth of Powder River, in Oregon, as more or less permanently inhabited by the locust, excepting the dry and barren region northwest of Great Salt Lake, concerning which we have no information.

We have ventured to indicate on the map a large area of the Snake River Valley, west of the 14th meridian, as a permanent and native breeding ground, from data, however, much more meager than we could desire.

Of the region indicated on the map and lying directly north of the Great Salt Lake, we have such full and satisfactory information, derived from the personal examination of two of the Commissioners, that we feel sure that the limits are accurate so far as drawn, though the area may prove to be larger than we have ventured to indicate. Records from the year 1851 show that with rare exceptions the Malade and

Cache Valleys have been annually more or less devastated. The swarms have invariably originated in the region to the north, in the valley of the Gallatin, Madison, and Jefferson Rivers. The area extends southward to Salt Lake City. The remaining portion of Utah is more or less barren, dry, and sandy, affording no pasturage sufficient to yield food to large numbers of locusts, or grasshoppers of any sort. Nearly all that visit the Salt Lake Valley come from the Bear River, Cache and Malade Valleys, while a few probably originate in the region east of the Wahsatch Mountains, and some may fly over from Western Colorado.

The State of Nevada affords no feeding grounds for the locust, for the same reason that they do not breed in the greater part of Utah, viz, the hot, dry, barren soil affording no grassy plains or fertile river-bottoms for the maintenance of extensive swarms of locusts, except in the valley of the Owyhee River, a limited tract in Northeastern Nevada. For the same reason Arizona and New Mexico are not the permanent abode of the Rocky Mountain locust.

A large and important area remains to be described, viz, that watered by the upper North Platte River and its tributaries, especially that portion of the Platte called the Sweetwater River, east of the 104th meridian. This area also includes the plains and valleys lying north and south of the Union Pacific Railroad, the valley of the South Platte west of longitude 105° 30′, and the upper Arkansas River, west of the same meridian. West of the Rocky Mountain Range the area probably includes the head-waters of the Yampah or Bear, the Snake and Green River Valleys, north of the 41st parallel. South of this parallel the region, which with our present information on a map of this size can be only approximately drawn, includes the Rocky Mountain Range. In this range the permanent breeding grounds are restricted mainly to the elevated (8,000 or 9,000 feet) North, Middle, and South Parks, and to valleys lying below them, as well as to the areas more favorable to the propagation of the grasshopper lying among the foot-hills of the Rocky Mountains and the plains immediately adjacent. As a matter of fact, the farming regions lying near the range, as at Greeley, Denver, and the neighboring towns, are exposed to visitations in those years when the locusts multiply unduly in the permanent area, and it is doubtful just where the line between the foot-hills and plains in which these towns are situated should be drawn. Without much doubt, most of the swarms which devastate the farming portion of Colorado are mostly foreign to the State, and originate in Wyoming; while a few, sometimes, however, large and destructive, fly over the range from Western Colorado.

In conclusion, it will be seen that the areas marked on the map as forming the native or permanent breeding grounds of the Rocky Mountain locust comprise nearly all the available farming regions in the immense area of the United States lying between the 104th and 120th meridians. We shall be compelled to look squarely in the face the unpleasant fact that the sections in this area best adapted to agriculture,

and especially the raising of grain, are those where the locust breeds in greatest profusion, and where the climatic conditions are all favorable to its propagation.

On the other hand, it seems obvious that the more that is done by farmers in the future in destroying the young locusts within this permanent area, the more likely will their combined efforts, carried on from year to year, tend to the ultimate destruction of the locusts. And it follows that the more extensively this region is settled, the more will the locusts diminish in numbers. It is, then, only a question of time, and of immediate effort on the part of the present generation of farmers.

Another fact is established and proved by study of the distribution of the breeding grounds of this species of locust. While *Caloptenus femur-rubrum*, the common red-legged locust, and *C. atlanis*, the lesser red-legged locust, have an immense natural range, breeding annually in abundance from Middle Florida to near the Arctic Circle or northern limit of forests, on the east and westward ranging as far south, approximately, as the 40th parallel in Utah and California, *C. spretus* is permanently restricted to an area north of the 40th parallel, only extending southward along the Rocky Mountain Range, or periodically visiting the Great Basin south of this parallel. On the other hand, its more extensive and continuous breeding grounds lie north of the 42d parallel and on the elevated plateau of the Rocky Mountains above an altitude of 2,500–3,000 feet. It breeds in destructive numbers in the Rocky Mountains south of this parallel, between 5,000 and 8,000 feet elevation. North of the 53d parallel it does not probably extend, and it is not so boreal and even subarctic an insect as the two previously named species, both of which occur on the summit of Mount Washington, in New Hampshire, while *C. atlanis* ranges as far north, on the Pacific Coast, as the Yukon River.

It would be safe to regard *Caloptenus spretus* or the Rocky Mountain locust as a north subtemperate or sub-boreal insect, viz, an inhabitant of what is called by naturalists the north subtemperate zone of life, situated between the annual isothermals of 50° and 36°.[20] In vertical distribution it may be said to breed from an altitude of about 2,000 feet up as far as 10,000 feet, or near the timber line in the Rocky Mountains, though few probably breed in great numbers above an altitude of 8,000 feet. The elevated plains of Colorado, Northern Utah, Idaho, and Wyoming, where it breeds so abundantly, correspond in a general way to the rather lower plains of Northern Montana and British America. The Rocky Mountain locust, then, like the antelope, the Rocky Mountain sheep, the prairie dog, the bison (as now restricted in its range), pouched marmot, and a number of peculiar birds, reptiles, insects, crustacea, and many trees and plants, is a form purely characteristic of the central

[20] The boreal zone, in North America, comprises the Canadian and American subarctic zones. While *C. femur-rubrum* (and probably *C. atlanis*) ranges from the subarctic zone, through the boreal, Canadian, Alleghanian, Carolinian, and Floridan belts, *C. spretus* ranges permanently through what corresponds in the central region of the continent to the Alleghanian or subtemperate and Carolinian or temperate zones or divisions. There are some features in the animal life of this central province which strikingly recall the forms characteristic of the steppes and plateaus of Northeastern Asia.

zoogeographical province of North America, not occurring in the Pacific province or in the eastern or Atlantic provinces, except in the latter periodically.

SUPERMANENT REGION.

II. The region in which the locust breeds less permanently, but is liable to be invaded each year when it multiplies in excessive numbers in its truly permanent breeding or hatching grounds, lies immediately east of the 104th or 105th meridians, on the elevated plains east of the Rocky Mountains. The altitude of this area constantly diminishes eastward until in elevation and the character and contour of the soil it fades into the region intermediate between the plains and the prairies of the western edge of the Mississippi Valley.

The eastern limits extend north of the 45th parallel to the 97th meridian approximately. From Fort Ransom, on the Cheyenne River, the line demarking the eastern limits curve southward and westward to Pueblo City, Colo. This region includes a large portion of British America between the United States boundary line and latitude 53° north, and between the 97th and 104th or 105th meridians. It includes nearly all of Dakota, the western third of Nebraska (now mostly unsettled), the extreme northwest corner of Kansas, and comprises the northern half of Colorado, east of the Rocky Mountains.

Between the permanent and subpermanent breeding area there are no natural barriers, one region shading imperceptibly into the other, the limits between them being arbitrarily drawn.

TEMPORARY REGION.

III. This region is represented on the map by the dotted area east of the great plains. South of the 42d parallel, and west of the limits of the subpermanent breeding grounds, the region is nearly correct; but in Wyoming, Idaho, and Montana the limits are only approximately given, and are liable to future correction.

CHAPTER VI.

GEOGRAPHICAL DISTRIBUTION.

As the preceding chapter, on the "native breeding grounds," contains as complete a statement of the nature and extent of these as we are able to give from our present information, and the chapter on "migrations" contains a somewhat full account of the movements of the swarms within the area overrun by them, we shall devote this chapter simply to tracing the extreme limits of the migrations, or, in other words, the bounds of the locust-visited area, and to an explanation of what we term the "subpermanent region."

THE EASTERN LIMIT OF MIGRATIONS.

As will be found stated elsewhere, the eastern limit of their range, although marked by no permanent, natural barrier, such as a mountain range or large body of water, is probably as well defined and as rigidly fixed as it is by the forest-clad Sierra of Nevada on the west. Although the highest ranges and loftiest peaks of the Rocky Mountain belt from British America to New Mexico seem to offer no impediment to their movements, and to form no part of the boundary-line of their native breeding grounds or migrations, yet we can mark along the level or undulating prairies of Minnesota, Iowa, Missouri, Indian Territory, and Texas, almost with the precision of a surveyor, the utmost limit of their movements eastward. Why a swarm driven by a northwest wind, when approaching this limit, should drop down rather than move onward to the east of the Mississippi will be discussed elsewhere. All we have to deal with here is the fact which authorizes us to fix this line as the eastern boundary of their movements, not of one or two years, but generally. If it were the limit of the flight of invading swarms, we might conclude that it simply marked the terminus of their flight, and hence had no real limital value, but when resulting swarms are seen in hundreds of cases stopping at it, although not exhausted or wearied by length of flight, we may reasonably conclude that this is the limit of their range, whether we can assign a satisfactory reason for it or not.

It is due to the memory of Mr. Walsh, formerly State entomologist of Illinois, to state here that he was the first who expressed the belief that these locusts would never cross the Mississippi River. This opinion was stated in the following language, in October, 1866 (Practical Entomologist, vol. i, p. 5):

> I do not think that it is at all probable that these Colorado grasshoppers will ever cross the Mississippi, as the Colorado potato-bug has done, and pass onward to the Eastern States. In the latter case there were physical obstacles to the eastward spread of the insect previous to the settlement of the Rocky Mountain region. But in the case of the Colorado grasshopper there was no such obstacle; and as they [have] not heretofore spread eastward there is no reason to believe that they will do so hereafter.

In his "first annual report" as acting State entomologist of Illinois, published in 1868, is a somewhat lengthy article on these insects, in which he discusses more at length this subject, fixing the eastern limit of their range in Iowa in Polk County, or "115 miles" west of the Mississippi. He mentions also their eastern extension in Minnesota to Anoka County; in Southern Iowa, to Clarke and Page Counties; in Northwestern Missouri, to Nodaway County; in Texas, to Red River, Hunt, Austin, and Lavaca Counties. As will be seen hereafter, three of these counties, Anoka, in Minnesota; Clarke, in Iowa; and Red River, in Texas, mark the extreme eastern limit in their respective latitudes, and the others adjoin or lie near the most eastern counties to which the locusts have since extended their migrations.

The eastern limit in Missouri is defined in Mr. Riley's account of the

invasion of 1874, as given in his seventh annual reprot. With the exception of a single county, visited in 1877, the migrations have not extended east of the line as marked on his map in that report.

We will now give a list of points along the eastern limit to which we have positive knowledge that the migrations of the locusts have extended; a few points further east have been mentioned as among those visited, but the testimony in reference to them is too doubtful and uncertain to be used in fixing this eastern line. In connection with the points mentioned, the authority from whom the information has been obtained is given in all cases, except where the facts have been ascertained by the Commission since its organization. Where limits previously fixed were reached by swarms in 1877, we have relied upon our own data; hence in such cases no authority is mentioned. This arrangement will enable the reader to note the points along this line which the Commission has been able to determine from observations made in 1877. It will also enable him to mark the eastern range of flights for that year.

British America.—According to Prof. G. M. Dawson, movements toward the northeast have extended to the southern end of Lake Winnipeg. From the reports received and recorded by him it is quite probable that their migrations at this northern extremity of the visited area have extended as far east as the 96th meridian. He also records their appearance in 1875 at "Northwest Angle," Lake of the Woods. The swarm seen passing this point moved onward toward the southeast.

Minnesota and Wisconsin.—From the Lake of the Woods southward to the line of the Northern Pacific Railroad, with the exception of Indian villages on the reservations, there are no settlements, consequently no data from this area have been received, except some verbal reports that swarms of grasshoppers have been seen (no date given) at Red Lake and Leech Lake stations. From the latter point southward the line through these States is represented by the following counties: Cass, Aitkin (Thomas, observation in person in 1872), Benton, and Sherburne, Anoka (1856–'57 Walsh), Ramsey, Dakota, Pierce (Wisconsin), Dodge, and the extreme southeast corner of Mower.

Iowa.—The following counties in Iowa indicate the eastern limits of the migrations in that State: Eastern line of Mitchell, Floyd, Butler, and Grundy; Tama and Poweshiek; Warren and Clark (1867, Walsh); and Taylor. A flight over Appanoose County in 1876 is reported, but this is very doubtful. Mr. Walsh also mentions reported flights in the neighborhood of Dubuque, but the evidence is not entirely satisfactory in reference to the flights or the species. It is possible that now and then a light swarm may be driven beyond what is the usual limit, but we are not tracing these at present, our object in this chapter being to fix as accurately as possible the true limits of their geographical distribution.

Missouri.—The following counties along the eastern limit of their movements in Missouri were visited in 1877: Polk, Dade, Lawrence, and

Barry; the rest of the line through the State is that which was designated by Mr. Riley, in his seventh report, as the eastern limit of their incursion in 1874, which passes through the following counties: Harrison, Daviess, Caldwell, Ray, Lafayette, Pettis, Benton, and Hickory.

Arkansas.—In Arkansas, only the extreme northwest portion appears to have been visited since 1867, at which time, according to the Monthly Report of the Agricultural Department, they penetrated to Montgomery County. Since then, Mr. Riley's reports up to 1876, and our own correspondence for 1877, show that their incursions into this State have extended only over Carroll, Benton, and Washington Counties.

Indian Territory.—The data in reference to movements in Indian Territory are very meager: that they have reached the eastern boundary as far south as Washington County, Arkansas, since 1867 is certain; that they have also extended east of Fort Gibson is also known positively. The next point south of this reached since 1867, of which we have any certain knowledge, is Grayson County, Texas. But in 1867, when their migrations extended eastward to Montgomery County, Arkansas, they also reached Red River County, Texas; hence, in all probability, including all of Indian Territory.

Texas.—Through Texas the line may be designated by the following counties: Red River (1867, Walsh, and Monthly Rep. Agl. Dept)., Hunt, (Walsh); Anderson, Grimes, Harris, Austin, Colorado, Lavaca, Victoria, Goliad, and Live Oak.

We have been unable to trace them into any of the coast counties in this State, or to the Mexican line on the Lower Rio Grande; yet it is quite possible that swarms have been driven to the gulf shore southwest of Galveston; but the southeast limit of their range appears to be quite constant in the second tier of counties, seldom reaching nearer than thirty miles of the coast, as we are informed by the United States signal-service officers located in that part of the State.

By noting on a map the localities given it will be seen that the eastern limit of their range is marked by the following line: From the southern end of Lake Winnepeg, by way of the Lake of the Woods, to Pierce County, Wisconsin; thence almost directly south to Poweshick County, Iowa; thence southwest to Worth County, Missouri; thence, south through Montgomery County, Arkansas, to Houston, Texas, curving westward from this point to Live Oak County. The various bends or flexions in this line are in all probability due to the forests with which the line from the middle of Iowa southward appears to correspond. That this is the case in Southern Iowa and Missouri is certain; but in Minnesota this rule does not appear to hold good, at least to the same degree as farther south. In Manitoba the eastern and also the northern limit corresponds very closely with the timber line.

NORTHERN LIMITS.

According to Professor Dawson, who has devoted much attention to the study of the history, habits, and movements of the locusts in British America, "northward they appear to be limited by the margin of the coniferous forest which opportunely follows the line of the North Saskatchewan River." In the Northeast they have evidently passed beyond this line, as they have been seen at Swan Lake House and occasionally at Cumberland House, showing that in this direction they occasionally penetrate to the northern end of Lake Winnipeg. Westward from this point the limit line appears to bend southward, passing between Prince Albert and Fort Carleton, following very nearly the 53d parallel by way of Battleford and Fort Pitt, running a little south of Fort Edmonton, the Battle River Valley being sometimes infested by the locusts. From near Fort Edmonton the line curves around and follows the eastern flanks of the Rocky Mountains down to Fort McLeod, in longitude 113° 40′, latitude 49° 35′. The northernmost limits, then, extend to Fort Pitt, in latitude 53° 40′ (approximate), and the general northern limits of the range of *C. spretus* extends nearly to the southern limits of the forests which lie partly upon the 53d parallel, but, in greater part, between longitude 104° and 114°, above the projected route of the Canadian Pacific Railroad.[21] We know nothing of the species of *Caloptenus* which probably inhabits the fertile area between Athabasca and Peace Rivers. Mr. H. Scudder has a specimen of *Caloptenus atlanis* from the Yukon River, and while it is probable that the boreal and subarctic region, north of latitude 53°, is inhabited by *Caloptenus atlanis* and *femur-rubrum*, which thus range from the Atlantic to the Pacific Oceans, it is probable that the long-winged migratory *spretus* does not range beyond the line of coniferous trees lying along the north shore of the north branch of the Saskatchewan River.

WESTERN LIMITS.

North of latitude 44° the westernmost point in which the Rocky-Mountain locust is known to breed abundantly at certain seasons is in the Missoula Valley, which lies on or near the 114th meridian.

Between Missoula and Lewiston there are no locust breeding grounds, so far as we know; still, as locusts were known in 1875 and 1876 to

[21] Since the above was put in type we have received from the author Mr. G. M. Dawson's Notes on the Locust in the Northwest in 1876 (*Canadian Naturalist*, vol. viii, No. 7), in which he states: "The range of the locust is really limited to the north by the southern margin of the forest-clad country, and may be roughly defined by a line nearly as follows: From the intersection of the 96th meridian and 49 h parallel of latitude to the south end of Lake Winnepeg, thence to Manitoba Lake, and following this lake and Winnipegosis Lake; from the north end of the latter westward to the Forks of the Saskatchewan, till the wooded country at the base of the Rocky Mountains is attained." He quotes Mr. S. D. Mulkins, of Battleford, who says: "From all the information I can collect, I cannot find that the grasshopper has ever visited any of the Hudson Bay Company's posts north of latitude 53°. I have never heard that they have ever penetrated to the Peace River country. . . . At Fort a la Corne, Prince Albert Mission, Turtle Lake, Lac la Biche, Lac la Nun, and Lac Ste. Anne, they have never been seen; and these places are all on the verge of the great forest or just within its southern limit."

commit local ravages on the Pataha River, at a point 40 miles northeast of Walla Walla, there seems no doubt but that scattered broods inhabit the valley of the Snake River, and may originate in the south, near Fort Boise, or even fly over the Bitter Root Mountains from Central Montana. It is more probable that the whole valley of the Snake River, where the soil is fertile, is inhabited by locusts, from its source in the Rocky Mountain Range. Lewiston is said to have been visited by locusts, and a large swarm appeared during the past summer in Baker County, Oregon; but the westernmost point to which the locust is known to have reached is Camp Harney, about 175 miles south of Umatilla, in longitude 118° 30′ west, latitude 43° 30′ north. At this point it has occasionally abounded, so that in certain years it has been impossible for the garrison to cultivate gardens. Beyond this meridian the Rocky Mountain locust has not been traced. It is not probable that flights have ever been borne by winds to the eastern flank of the Cascade Range in Oregon and Washington Territory, as the desert, hot, dry, grassless region which forms the western edge of the Great Plains of the Columbia, as have been observed by us, is much like the desert region of Nevada, with nothing but sage-bushes to support locust-life. It is not probable that any swarms pass over the Cascade Range or the Sierra Nevada, and indeed there are positive facts to the contrary, as will be seen in our chapter on the migration of the locust.

The next well-established locality in the western limits of the Rocky Mountain locust is a point on Humboldt River, a little west of Humboldt Station, where it was observed in considerable numbers by Mr. Thomas in 1871. No specimens of *Caloptenus spretus* have been found in the southern portion of Nevada, except that it has been reported at Saint Thomas, near the Utah line, and not very far from Saint George, Utah, where we know the species has been observed. It is evident, therefore, that the migrations of this species in this latitude do not extend farther west than the eastern base of the Sierra Nevada, and then only as straggling swarms from Northern Utah or Southern Idaho, and chiefly along the line of the Central Pacific Railroad.

SOUTHERN LIMITS.

The data we have been able to obtain for determining this line are very limited in number, and by no means satisfactory; in fact, we may say that, so far as locust movements are concerned, this is almost *terra incognita*. All we can say in reference to this line is that they have been known to cross the Rio Grande at Eagle Pass, and penetrate a mile and a half into Mexico; that they have been observed in Western Texas as far as the settlements have extended; that they have penetrated New Mexico on the northeast as far as Las Vegas and Fort Union, and have passed down in the mountain region from Colorado to Taos, and possibly farther south.

According to Mr. Taylor's account, as given in the Smithsonian Report for 1858, New Mexico was overrun by them in 1855; but so far we have been unable to procure any data by which to verify this statement; on the contrary, all the facts ascertained seem to contradict it. Statements have been made in reference to their migrations down the Rio Grande to the vicinity of the Hornado del Muerto, while on the contrary it is asserted they have never been seen at Santa Fé. Both of these are doubtless incorrect.

We have no positive evidence in reference to the locusts in Arizona further than that they have been seen in the neighborhood of Saint George, Utah; but the negative evidence indicates pretty clearly that, with the exception of the northern border, this territory is not subject to the visitations of the Rocky Mountain locust.

We may therefore give the boundary so far as now known, about as follows: From Eagle Pass, Texas, to Santa Fé, N. Mex., thence west along the 36th parallel of latitude to Southeastern Nevada.

SUBPERMANENT REGION.

East of the mountains, between what we have described in the preceding chapter as the "Permanent Breeding Grounds," and the more eastern section or temporary region which is visited only at irregular periods, is an irregular and not easily defined area, which forms a kind of debatable ground, which cannot be distinctly classed with either of these regions. As will be seen by reference to the chapter on migrations, the movements in the sections north of Nebraska and Iowa do not appear to be so regular as those of these States and the area south of them. In other words, as we move northward the characteristic distinctions by which we are enabled to define the permanent breeding grounds and area periodically visited gradually fade away, and we enter an area where, although apparently not in their native habitats, the locusts appear more at home than farther south and southeast, *i. e.*, they appear to be able to continue with considerable vigor for two, three, or four years in succession. There are some reasons for believing that the Coteau of the Missouri and the Coteau des Prairies have some influence in this matter, but the facts ascertained are not sufficient for us to assert this with confidence. That the species is boreal in its habits and characters is now admitted as beyond controversy; hence it is to be expected that as we move northward, where mountains are not necessary to furnish the climatic conditions they require, the distinctions between permanent breeding grounds and visited areas will be less marked. This middle or subpermanent area is necessarily a shifting one, depending more or less upon the character of the seasons. Without attempting to give it any definite boundary, we may state that, so far as we have been able to ascertain, these conditions are found in Western Manitoba, Eastern Dakota, Eastern Colorado, and Northwestern Nebraska.

CHAPTER VII.

MIGRATIONS.

The locusts are the only insects which may be properly termed migratory. It is known that certain butterflies pass in swarms from one place to another, but such flights are local. Swarms of *Danaus archippus*, a common butterfly, have been seen in the Mississippi Valley either in the spring or autumn, but not flying long distances. In the Old World the migratory locust is known to fly for a distance of four or five hundred miles into central Europe from its permanent breeding-area in Asia. The flights taken by locusts in North America may extend over a distance of between one and two thousand miles, from their native breeding-places in Montana, for example, to Kansas and Missouri, and perhaps Texas. As a rule the flight is undertaken only during a part of the day, and in fair, clear weather, so that the desire for food, cloudy, rainy weather, and adverse winds may keep them from rising and taking wing. In a favorable day they rise early in the forenoon, from eight to ten o'clock, and settle down to eat by four or five in the afternoon. The rate at which they travel is variously estimated from three to fifteen or twenty miles an hour, determined by the velocity of the wind. Thus insects which begin to fly in Montana by the middle of July may not reach Missouri until August or early September, a period of about six weeks elapsing before they reach their destined breeding-grounds.

In order to avoid circumlocution in speaking of the various kinds of flights of the Rocky Mountain locust, the Commission has been compelled to adopt certain terms by which to designate them.

Invading swarms.—This term, when used in reference to their movements east of the mountains, applies to those swarms or hordes which move down from their native hatching-grounds in the West and Northwest, into those sections where they are not permanent residents. It is only applied to those hatched in their native habitats, and not to those swarms which having hatched in the visited area move northward or northwest and then return, as is often the case.

Returning swarms.—This term is used to designate those swarms which, having hatched in the invaded district where they are not permanent residents, and having acquired wings, led, apparently by some natural instinct, return to their native home in the Northwest and West.

Local flights.—This is a term used to designate the movements of those hatched in the invaded district, to and fro, from point to point in that district. It is not so accurate and definite in its application as the other terms mentioned, as it is applied to those movements to the north and northwest, no matter how general they may be, if the swarms appear to fail in their efforts to reach their native home. But notwith-

standing this indefiniteness it includes a very large number of movements not embraced by either of the other terms, and comprises most of the movements east of the mountains in 1877.

The height at which swarms move.—To determine this with any exactitude is almost an impossibility, as the swarms do not move in broad sheets, as many who have never observed a flight imagine, nor are they generally in a compact body whose boundary is well defined, forming a clear line; but more like a vast body of fleecy clouds, or still more correctly, a cloud of snow-flakes; often having a depth that reaches from comparatively near the ground to a height that baffles the keenest eye to distinguish the insects in the upper stratum. Professor Aughey has made some attempts at measuring the height of swarms, and in some instances has succeeded in ascertaining pretty correctly the elevation above the surface, and also the depth of the swarm. But the only important question to be decided in reference to this point is, whether they can and do fly at an elevation so great as to carry the entire swarm out of view on a clear day.

There are some very strong reasons for believing that such is the case, and as it enables us to account for some hitherto unexplained facts we are disposed to assume that it is true, at least it is a point worthy of investigation.

The Signal Service officer at Bismarck states that he observed a swarm on one occasion flying above the (cumulus) clouds. Correspondents in in their reports of flights often speak of them as being "very high."

In numerous instances they have been brought into view by field-glasses when invisible to the natural eye; and it was ascertained last summer that they could be seen distinctly through smoked glass when scarcely visible with the natural eye.

But the strongest evidence in favor of the view that they very probably do often fly at an elevation above the plains of the border States which renders them entirely beyond the natural vision is the fact that they *can* fly at that height. That it is no uncommon thing for cranes and wild geese to fly north and south along the Mississippi at a height which carries them entirely out of view is well known, as their notes can frequently be heard overhead when the eye searches in vain for them. At what elevation these move it is impossible to tell, but it is not probable that it is much, if any, over two miles; and it is reasonable to suppose that a height which would render them invisible would render a swarm of locusts invisible, as the latter are seen not so much as a *mass* as *individuals*.

Mr. W. M. Byers states that in 1868 "from the middle to the 25th of August I was upon the Snowy Range east of Middle Park and on Long's Peak. There was a large daily flight of full-grown grasshoppers from west-northwest reaching apparently to the highest limit of vision when on the highest peaks."

Mr. J. D. Putnam was on Parry's Peak in 1872 during the time a

swarm was passing over. He states that "they could be seen filling the air like snow-flakes to a great height above the extreme summit of the peak, 13,333 feet."

It is evident from these facts that they can fly at an elevation of 15,000 feet above the sea-level, or about two miles and a half above the general surface of Kansas and Nebraska; and far out of sight of the keenest vision.

As they are natives of the dry, elevated table-lands of the Northwest and the region of rarefied air, it is more than probable that one object in leaving the abundant pasturage they find amid the fields and prairies of the border States is to search for a drier and more rarefied atmosphere; and led by instinct to seek for this in the upper regions, they continue to ascend until they reach the limit of their power of upward flight.

If this be true it will explain their often sudden and mysterious appearance at points far within the bounds of the settled areas without anything having been seen of them along the line they came. It will fully and sufficiently account for the difficulty of tracing individual swarms along the line of their march.

Effect of a change of wind or weather on flights.—A large number of facts have been collected which go to prove that as a very general, or, as we may perhaps truly say, universal rule, a sudden change of wind brings a flying swarm to the ground. From the fact that very often with a return of the wind to its former direction they rise and move on in the course they were going when stopped, it has been taken for granted that they have a desire to move in a given direction, and will therefore only rise and fly when the wind is blowing in a direction that will enable them to carry out this purpose. The very large number of instances noted where they have been stopped by contrary winds and refused, apparently with a dogged determination, to move until the wind was right to carry them on in their original course, would seem to be sufficient to confirm this theory. That it has, at least, some foundation in fact we think must be admitted; yet we are satisfied it is used to explain numerous movements and phenomena which are due to other and wholly different causes.

That a sudden change in temperature to a lower degree will as surely bring a flying swarm to the ground as a change of wind, is now admitted by all who have studied or observed the habits and movements of these insects. This is probably one great reason why they so generally come down at the approach of night, as the temperature usually falls very rapidly on these Western plains as the sun disappears. Whether they *ever* wheel round in the air and move back on their course without first coming down it is impossible to say, but so far no case of the kind has been observed of which we have received any account. Some of the movements in Minnesota during the past year led Mr. Whitman to think such a thing possible, as it would enable him to explain certain facts

otherwise shrouded in uncertainty; still, he did not feel warranted in venturing more than the suggestion that such might possibly be the case. Although all direct observations of which we have any knowledge seem to contradict this idea, yet there are some facts in reference to the flights along the eastern limit of their range which are difficult to explain unless we suppose a change in direction without alighting; such, for example, as swarms flying in an easterly direction at this limit, which are never heard of beyond it or on the east side of it; also, swarms seen coming from an easterly direction at points along this limit which were never heard of before being seen passing westward. It is true that a large number of such cases can be accounted for by the very probable supposition that those going eastward came down unnoticed, which we found to be a very common occurrence, even to a degree which could scarcely be believed by those who have not had an opportunity of observing the fact. Others can be accounted for in other ways, yet after all these eliminations there are still some cases left which can scarcely be accounted for without supposing a change in the direction of flight without alighting.

As is shown further on, there are instances where two swarms were seen moving in different directions at the same time, one in an upper current and the other in a lower; also, to one case where a swarm was flying south in an upper current, while a lower current was moving in an opposite direction. It is by no means unreasonable to suppose that in some cases the swarm descending or ascending gradually reverses its course or moves with the other current. In reference to the double flight which he observed on July 26 at Ponca, Nebr., Professor Aughey remarks, "that at the point or line where the two currents met the locusts seemed to intermingle."

The solution of these minor problems is of the greatest importance, for their determination virtually determines the chief theory in relation to the locust migrations. If their alighting is caused by the difference in temperature of the opposing winds or some other atmospheric condition than simply the direction in which it moves, it follows as a matter of course that they do not drop simply because they are prevented from moving on in the direction they wish to go—a point on which the theory of the "returning swarms" chiefly hinges. We are satisfied that the facts so far ascertained in reference to these points, taken together, indicate very clearly that their pauses cannot be fully explained by differences in temperature or simple atmospheric changes, and that the only reasonable explanation which can be given for many of their stoppages is, that they are prevented by opposing winds from moving on in the direction they desire to go. Still, on account of the very important bearing it has upon the locust problem, and upon the possibility of our predicting with certainty their movements in advance, we think it deserves a more thorough study and additional investigation.

As bearing upon the point now under consideration we quote the following from Mr. Byer's letter elsewhere mentioned:

Along toward noon, on bright warm days, they rise by circular flights, each seeming to act individually, to a considerable height, and then all sail away, with tolerable regularity, in one general direction. If there is no wind many of them continue whirling about in the air, like bees swarming, but away beyond, myriads can be seen moving across the sun toward the southwest, looking like snow-flakes. If there is a change in the atmosphere, such as the approach of a thunder-storm or gale of wind, they come down precipitately, seeming to fold their wings and fall by the force of gravity, thousands being killed by the fall if it is on stone or other hard surface. If not interrupted by such causes they descend during the afternoon.

It is proper to call attention here to the fact that Mr. Byers is speaking of the phenomena of their flights close to and immediately east of the Rocky Mountains, where there is often an upper current of air moving eastward or southeast, while the atmosphere near the surface of the ground, protected by the mountain-wall, may be comparatively undisturbed—a condition not found on the plains, where the mode of rising is usually different from that here described.

Each Commissioner has had the pleasure of witnessing, in the mountain region, this habit of the locusts, of circling upward behind some shielding ridge, apparently for the purpose of ascertaining the condition or direction of the upper current, and suddenly dropping when it proved from some cause unfavorable.

Flights during the night.—We have received but few reports bearing on this point; in fact, it is not likely that flights, under any circumstances, could be seen at night. Still, there are good reasons for believing that these are by no means uncommon.

On one occasion, Professor Aughey, while traveling at night, near midnight encountered a sudden change of wind, and, at the same time, hosts of falling locusts. We have also received an account of a well-attested case of a swarm coming down at eleven o'clock in the night at a station in Nebraska a little west of Crete. A large number of instances have been reported where swarms were observed flying late in the evening, which, so far as could be ascertained by diligent inquiry, did not come down in the vicinity of the place where last seen. There are also reports of numerous cases where they were observed on the ground early in the morning, yet none were seen the day before. In addition to this strong testimony on the point, there are other facts in reference to their movements which cannot be explained on any other supposition.

We are satisfied, therefore, from all the facts we have been able to gather bearing upon this point, notwithstanding the very general opinion of the people in the locust-area to the contrary, that flights at night are by no means uncommon. This, in connection with the fact that they can and probably do often fly at such an elevation as to be invisible, will fully account for their repeated mysterious appearance when it is impossible to hear anything of them along the line they come.

MIGRATIONS OF THE ROCKY MOUNTAIN LOCUST PREVIOUS TO 1877 IN THE STATES EAST OF THE ROCKY MOUNTAIN PLATEAU, I. E., EAST OF LONGITUDE 105° (APPROXIMATE).

I. *Migrations into the States late in the summer and early in the autumn.*—The following are all the facts positively known regarding the course taken by the swarms entering Texas, Indian Territory, Arkansas, Missouri, Kansas, Nebraska, Iowa, Minnesota, and Dakota, previous to 1877. For most of the data we are indebted to Walsh's First Annual Report on the Injurious Insects of the State of Illinois, and Riley's Seventh, Eighth, and Ninth Reports on the Injurious Insects of Missouri.

1821.—Swarms of locusts entered Missouri flying from the northwest.

1864.—Swarms entered Iowa and Minnesota from the northwest. None are reported to have flown into the region south.

1865.—They flew into Minnesota from the west and northwest.

1866.—There was a general invasion from west and northwest. In Texas, in Collins County and at Uvalde, the flights were from the northwest, the wind being northwest.

In Missouri they apparently came from Kansas into Cass County, and Northwestern Missouri was "overrun from Kansas and the Far West." In Holt County late in September they came in millions from the south-southwest and west.

In Kansas the locusts first entered the State appearing in the frontier settlements September 12. According to the Leavenworth papers, September 1, at Council Grove, a tremendous shower of grasshoppers came from the south, completely filling the air as high as one could see and looking like a driving snow-storm. In Northwestern Kansas they filled the air so as to obscure the sun. They were traced for a distance of 200 miles above Fort Kearney. The Leavenworth papers reported that a vast army of grasshoppers reached Lawrence from the west. The prevailing winds in the State during August and September were westerly. (Walsh in Practical Entomologist, ii, 3, 4.)

In Nebraska, according to several observers, quoted by Mr. B. D. Walsh, the locusts late in the summer of 1866 came from the west or from a northerly direction. An observer at Peru, Nebr., reported to the Agricultural Department that "in October last the grasshoppers came from the northwest and deposited their eggs." It is obvious that these swarms came from the Rocky Mountain plateau, and probably the valley of the Upper Missouri and Yellowstone as well as the North Platte, and their tributaries.

1867.—In this year the migrations were late in the summer, and were more wide-spread than in the previous year. Into Dallas County, Texas, the locusts flew from the west and traveled east; in Lampasas County they flew toward the southeast, *i. e.*, from the northwest; and in Coryell County, from the north.

In Missouri they were commonly supposed to have come from the Rocky Mountain region.

In Kansas they flew very generally from the northwest. At Council Grove they were observed passing to the southeast in great numbers; at Holton, Kans., they seemed to have come from the northeast, as Walsh states that according to an observer at Holton, "they can be seen by millions passing to the southwest," but this may have been a local variation in their flight.

In Nebraska the swarms came from the same general direction as in the year previous, namely, from the northwest. An observer at Richland states that August 29–31, for a period of two and a half days, there was a constant influx of grasshoppers from the northwest.

In Iowa the invasion of locusts came from the westward, according to Mr. Walsh, who quotes from two independent sources, the statement that "the Kansas grasshoppers, which for six weeks past have gradually made their way eastward, appeared at Osceola, Clark County, early in October." At Algona they came September 30, in large numbers, and "seemed to come from the west or southwest." In Pocahontas County they came from the southwest September 10.

1868.—This year locusts appeared in Riley County, Kansas, flying apparently from the northwest, August 7; a southeast wind prevented their leaving on the 8th. (It is possible that the swarms came from Iowa and Minnesota, rather than from the west.)

In Iowa the flights were from the northwest, as it is stated that a strong wind from the northwest carried the locusts August 8 into Page County.

In 1873 locusts entered Texas in September from the north, the wind being northerly.

In 1874 all the accounts indicate that the flights were from a general northwesterly course. We can find no records relative to flights in Texas absolutely indicating that the swarms came in any other direction than from the north or northwest.

In Missouri the flights are stated by Mr. Riley to have been from the Rocky Mountain region. The general direction from which they came was from the northwest, the reports showing remarkable agreement in this respect. The greatest deviation from this course occurred in the more eastern or last counties visited, when the army became pretty well thinned out and demoralized, and flew about with less uniformity, being more governed by the wind. The dates at which they are reported from the different counties are interesting, and show that the insects advanced at an average rate of not more than three miles a day. That they travel at a far greater speed, every one who has witnessed their migrations is aware, and this low average rate is due to the fact that the insects were no longer as vigorous and numerous as they had been in the country to the west. Another interesting fact is deducible from the returns, viz, that the rate of advance was greater in the counties first invaded than those last reached—a fact indicating that the insects were getting more and more exhausted and less desirous of flight the

farther east they came. They reached Holt County on the 8th of August, and all the counties in the same line, north and south, from Worth to McDonald, were reached during the latter part of the same month. They then continued to make short flights, and finally reached their extreme eastern limit toward the last of September. The correspondents do not agree as to whether the wind has much influence on their flight; but the majority of the reports show that, as is the nature of the insect in other States, it only flew in dense swarms when the wind was from the northwest.

In Kansas the locusts appeared "in overwhelming hordes from the plains of Colorado on the west, and the fields of Nebraska on the north." "They have destroyed the entire corn-crops of Central and Western Kansas and left thousands of people in absolute destitution. They have tarried with us longer this year than usual, having been detained by adverse winds from making their usual annual southerly migration. They do not trouble us unless stopped in their course south by currents counter to the direction of their flight. In Franklin County they came about August 23d; a north wind brought them."

Nebraska was entirely overrun in 1874, the locusts coming in legions from the north and northwest during the last of July, namely, about the 20th. In Otoe County they appeared late in July and left on the 7th August. "The wind was blowing from the southwest at the time of their arrival, but I think there was an upper current of wind from the north, which carried the greater part of them past, not more than one in ten (apparently) coming down." (Quotation in Riley's seventh report.)

We can discover no facts opposing the view that in 1873 and 1874 the swarms which afflicted Iowa came from the northwest; there are no direct facts recorded as to the direction of the flights; but there are no facts indicating that they came either from the south or southwest or northeast.

In Minnesota clouds of locusts in July, 1874, came from Dakota and British America, and the year previous swarms came apparently from the northwest; there are no data showing that they came in 1873 from a direction different from that assumed in 1874.

While Dakota was overrun in 1873 and 1874, we have no authentic data regarding the course of the flights or the winds at the time of migration.

In 1875 Eagle Pass, Tex., was visited by swarms moving from the north in September (United States Signal Office), but north of this State up to the United States boundary line there was no general invasion from the northwest. From Dakota the locusts migrated from the middle of July until the middle of August, moving in a general south and, at times, southeast course.

In 1876 there were fresh arrivals in Texas from the north and northwest. At different points in Texas from September 8 until late in November the flights were from points varying from north to northwest. (Packard's Report to Dr. Hayden, 1877.)

"At Dallas, at noon September 20, 1876, the air was filled with the first swarm of locusts; by 5 o'clock in the afternoon none were in the air. Previous to this date up to the night of the 19th the wind had been south; it changed on the 20th to the northwest, and this wind brought the locusts in a swarm which must have been many miles long and broad, and from 1,000 to 2,000 feet high, as far as the eye could see. At 10 o'clock, September 21, the air was again filled as at noon of the preceding day, the northwest wind still blowing, and the grasshoppers passed on as the day before, until 4 p. m. On the 22d the wind veered to the south, and the locusts flew during the day in large numbers irregularly about, like a swarm of bees. This continued until noon of the 23d, when a southwest wind bore a large number to the northwest."

They passed across Indian Territory, from the north from the middle of September onward, appearing at Fort Gibson September 16 to 28.

In Benton County, in the extreme northwest of Arkansas, swarms in the autumn passed over from the northwest, but none settled.

In Missouri, according to Mr. Riley, the locusts entered the northwest corner of the State from the north and northwest early in September, and were to some extent prevented from extending farther by south winds. "They entered the southwest counties from the southwest nearly a month later, invading Newton and McDonald by September 23, and reaching the middle of Barry by the first of October, and Cedar by the middle of this month. It is quite clear that the eastern limit of the swarms which came from the north and northwest was receding westward after they reached Northwest Missouri, and that Southwest Missouri, Southeastern Kansas, and Northwestern Arkansas would have escaped had it not been for west and southwest winds that brought back insects which had reached south of these points." The locusts arrived a month later than in 1874, and in this respect the invasion of 1876 more nearly resembled that of 1866.

In Kansas the swarms flew in the main from the north and northwest. "The insects came into the northwest part of the State late in July and early in August, and were seen flying about in many directions, but mainly southward, during the whole month. Early in September the swarms thickened, and the wind blowing almost a gale from the west on the 7th and 8th of the month, and strong from the west and northwest for two or three days subsequently, the insects during that time swept down in darkening clouds over the greater portion of the State from the 98th meridian to beyond the 96th." (Riley's ninth report.) "I came through Kansas from Colorado (Denver) on the 5th and 6th September. *Caloptenus spretus* at that time extended about 100 miles east of the mountains, last of which point no trace of it was to be seen during daylight on the 5th. Next morning we struck locusts in small numbers at Brookville (Saline County), 180 miles west of Kansas City; in full force at Salina, 12 miles farther east; and found the east front of this line 4 miles west of Abilene, in Dickinson County, and about 150

miles west of Kansas City. Observing and inquiring at the stations in this 30-mile belt, I invariably learned that the flight of the locust was from the *north* and not from the *west*, as two years ago (in 1874). (Prof. F. H. Snow in Packard's report to Dr. Hayden, 1877.)

In Nebraska most of the flights were from the north or northeast early in August, *i. e.*, from Iowa, but late in the month (the 23d–25th) strong northwesterly winds carried them east and south. Still, the general movement was from the northwest. Early in August they reached the western portions of the State; on the 12th they made a forward movement, and appeared in the valleys of the Elkhorn, Platte, and Republican. "A soft, southerly wind, varied by an occasional thunder-storm from the northwest, prevailed to the 23d, when, by stiff northwester, the grasshoppers rose and came from their exhausted feeding-grounds upon the east and south portions of the State." (Riley's ninth report.) Of thirteen observations collected by Professor Aughey, from various points in Nebraska, at the end of July and in August, all show that the flights were from the northwest, north or west. (App. 8.)

We have tolerably exact data regarding the course of the swarms which entered Iowa in 1876. The State was visited by heavy swarms late in July and in August, which came from the northwest, as may be seen by the following statement from Riley's ninth report: "About the 1st day of August, the northwestern counties of this State were visited by heavy swarms. They appeared to cross the State line from Dakota and Minnesota at almost exactly the same date for Emmett, Dickinson, Osceola, Lyon, Sioux, and Plymouth Counties, and from here they swept at once out into the counties lying eastward and a little to the south. The direction of flight was a little south of east, and the rate at times eight or more miles an hour."

In Minnesota in 1875 there were no flights from the northwest, but return flights from the States lying south and west.

In 1876, however, "swarms came from Dakota, having been heard of on the 23d of July as passing over General Crook's army. These," as we learn from Mr. John C. Wise of the Weekly Review, Mankato, by letter of August 22, "pushed continuously to the southeast, and reached as far east as they were ever known to do, or as far as the corner southwest of Dodge County. * * * It was further noticeable that the insects came down with the northwest winds, and that when the wind changed to the south, as it did for several subsequent days, few of the insects returned with it. The general direction of the flights was from the northwest, with an occasional swarm from the north, west or southwest." In Dakota, locusts arrived July 28 "in immense numbers from the northwest."

The Manitoba district, which is really continuous with Minnesota in a geographical and climatic point of view, and may best be considered here, has been invaded from the west and northwest, and by return flights of locusts from Minnesota and Iowa. In the autumn of 1857 and

MAP

SHOWING MIGRATION

OF THE ROCKY MOUNTAIN LOCUST

— in 1874 —

Area ravaged in 1874, and which suffered most.

Scale of Statute Miles

1874 the course was from the west and northwest. This would indicate that they flew from the great plains lying mainly between the north and south branches of the Saskatchewan River, beyond longitude 105° (approximate). In 1875 the young which hatched from eggs laid the previous autumn flew in a general southeast course, the same as that pursued by their parents, and this direction of their flight took them in large numbers into the region about the Lake of the Woods, where they could do little harm, while small, unimportant swarms entered Minnesota. In 1875, 1876, and 1877 no swarms arrived in Manitoba from the regions lying westward or northwestward.

From the foregoing facts, we may conclude that the whole tier of States from Texas to Minnesota, as well as the Manitoba settlements, are in locust years always invaded by foreign swarms of locusts, starting mainly from the region which we have described as the permanent breeding-grounds. The *return flights* which we are now to consider, are the young hatched from eggs laid the previous summer and autumn by the foreign swarms.

MIGRATIONS OF THE LOCUST WITHIN THE PERMANENT BREEDING-GROUNDS.

Montana.—In Montana and that region of British America lying north of this Territory, the course of the migrations have been ascertained with a good degree of certainty, and we begin with the northernmost portion of the permanent breeding area, because it is in Montana that most of the swarms that fly into Eastern Idaho and Utah, as well as, perhaps, Wyoming, and sometimes even Colorado, usually originate. We will arrange our data by years and localities, and then draw general conclusions from the observations made since the settlement of Montana.

In 1862, between Sun River and Fort Benton, swarms were seen in August flying in a southerly direction toward Sun River from the direction of Fort Benton.

In 1863 they were seen at Fort Benton flying from the east, and at this point the locusts always come from the northeast and east, and depart in a west or southwest course. In 1873, locusts laid their eggs at Fort Benton and flew west and south.

In 1873, 1874, 1875, and 1877, locusts visited Fort Benton, flying from the northeast, more generally east and southeast, and departing generally in a southwest course. In 1876 the course was from the northwest, immense swarms nearly depopulating the country about Fort Benton and the whole region northward to near Fort Edmonton, a distance of about 200 miles, and flew east. At Forts Belknap and Browning all were observed to fly east at the end of June and early in July, flying eastward as soon as they were fledged. These were undoubtedly the swarms that invaded Minnesota, Iowa, and Nebraska late in the summer of 1876. That this exodus of locusts extended into the basin of the

Yellowstone and its tributaries, the Big Horn River, Powder River, North Fork of the Big Cheyenne, which drain the larger part of the Territory of Wyoming, is shown by the observations of Lieutenant Carpenter, United States Army, communicated to the Commission. The source of the swarms that invaded the States lying east of the 103d meridian is clearly shown to have been mainly from Eastern Montana,[22] and the region lying north up to the North Saskatchewan, and the northern half of Wyoming.

On the other hand, Eastern Montana was visited in 1875, and again in 1877, by large swarms from the east and southeast, and these again were evidently the locusts which bred in the States east of the 103d meridian in 1875 and 1877, from eggs laid in those States by the locusts which invaded them in 1874 and again in 1876.

For example, at Fort Shaw large swarms which were much more destructive than the local swarms seen in 1873 and 1874 were from the east, and, from information received at Fort Benton, a large area of Eastern Montana was invaded by locusts which must have come from the southeast of the Territory, and most probably were in large part return swarms from the border States.

While the general movement at Forts Benton and Peck on the Missouri River in 1876 was eastward and southeastward, locusts were observed at both points flying from the southeast and east; these may have been of local origin.

In 1877 the locusts flew from the east at Fort Peck June 20. These had evidently come from Minnesota. These are not to be confounded with the swarms that arrived August 13 and 14. At this date moderate swarms arrived from the east-southeast. Mr. O. O. Martson writes that "they were previously heard of 90 miles south of Fort Benton coming from the east. The swarms which visited Fort Benton the middle of August were probably an offshoot from the large swarms which arrived about that time south of us about 100 miles, the mountain-ranges having separated them." These swarms were probably those which invaded the Gallatin Valley and originated in the bad lands of the Yellowstone.

At Helena the locusts, so far as observed, arrived from the east over the Belt Mountains, from the direction of the Yellowstone River. On the other hand, at Deer Lodge Mr. Granville Stuart informs us that, while the prevailing winds are west and northwest, the locusts always come with north and northeast winds; these would bring them from the Sun River Valley (Fort Shaw).

The Lower Missoula Valley, lying west of Helena and Deer Lodge, was invaded in 1866 by swarms from the north and northeast and east, some passing apparently from British America down the Flathead River and over the Rocky Mountain divide in August. None were seen afterward from 1868–1874.

In 1875 another invasion, as Mr. Chauncey Barbour informs us, came

[22] Namely, that portion of Montana lying north of latitude 45°, and east of longitude 113°.

from the east. The swarms flying west had reached Helena July 8 to 10, and by the 17th or 18th July had nearly reached Deer Lodge, when they began to lay their eggs July 18. They reached Missoula about the 8th or 10th of August, when they began to deposit their eggs. In the spring of 1876 the young hatched out, moving in a southerly direction, and by the 20th or 25th of June acquired their wings and went south, remaining in the valley four or five days, and deposited their eggs at the head of the Bitter Root Valley about the middle of July. The next year (July 5, 1877) the locusts which hatched from eggs laid the previous summer were observed departing to the southwest.

South of Helena the flights, as observed at Hamilton and Bozeman and Virginia City, are usually from the east, over the high Belt Mountains which bound the Missouri and Gallatin Rivers on the east. At Bozeman the universal testimony from various persons showed that the main breeding-place of the locusts which afflict the Gallatin Valley is the Yellowstone Valley, which lies due east, though sometimes swarms arrive from the Judith Basin. They fly over the Belt Mountains, and the farms which lie close under the foot-hills do not usually, if ever, suffer, as the locusts are borne for a mile or two beyond the base of the mountains before alighting.

At Bozeman, in 1865, the locusts came late in the season from the northern and departed in a southwest direction. In 1866 they came both from the Yellowstone and Judith Basins, having been traced thence by emigrants. In 1876, however, instead of departing in a southwest course toward Virginia City, as they usually do, they seemed to join the general movement southeast, in the direction of the border States, *i. e.*, across the plains. Mr. R. M. Goin, of Bozeman, informed us that the locusts which infest Bozeman hatch in the bad lands of the Yellowstone, due east of Bozeman, and, when fledged, fly over the Belt Mountains, usually appearing at Bozeman about the 10th of July. In one summer they flew south from Stirling, and he saw swarms all the way from Stirling to Franklin, Idaho, or, as he expressed it, "they went ahead of him from Stirling to Franklin."

At Diamond City the swarms which had come from the east into the Missouri Valley went southwest, and landed in Jefferson Valley, according to Mr. S. W. Sutherlin. Virginia City, according to Mr. J. H. Baker, is visited by swarms which invariably come from a little north of east. The citizens first hear of them in the Madison and Gallatin Valleys, and if locusts hatch out in Sun River they are apt to have them at Virginia City. They depart in a course which takes them to Taylor's Bridge on the Snake River, a little north of Fort Hall.

It thus appears that in the arable portions of Central Montana, east of the Rocky Mountain Divide, the main source of locust-swarms is the region of British America lying directly north and east and the Judith and Yellowstone Valleys, separated from the Gallatin, Jefferson, and Upper Missouri Valleys by the Belt Mountains. In years of unusual

abundance, as in 1874 and 1876, and when other circumstances favor, they do not fly west and southwest, but there is a general movement eastward beyond the plains to the border States. On the other hand, Montana is liable to be visited by "return flights" of locusts which have hatched in the border States. Thus, when the border States are invaded, it would appear as if the Northwest, namely, Montana, Northern Wyoming, and British America, is partially depopulated, and it would seem as if this general exodus from the permanent breeding-ground was an exceptional phenomenon. For example, in 1877, while great numbers hatched in Colorado, Utah, Idaho, and the border States, Central Montana and British America north of it were almost entirely free from locusts, and this was most probably due to the exodus of locusts from this region in 1876.

Whether the swarms which entered Central Montana, in the year 1877 originated in the Judith and Yellowstone Basins, or flew from the border States, we do not know, but we are disposed to think that they were of local origin. Still, swarms flying from the southeast were observed July 20, on the Little Big Horn, by Lieutenant Carpenter.

The fact has been established, we think, that the swarms which usually invade Central Montana originate in the region east of the Belt Mountains and in British America. They lay eggs in the Sun River and Gallatin Valleys, for example, and the following year their progeny, as a rule, infest Eastern Idaho and Northern Utah, and the year following perhaps Central and Southern Utah. At any rate, as shown on our map, the main source of supply of the locusts which infest Utah, and the region about Franklin, Idaho, is Central Montana; Central Montana receiving its locusts primarily from Eastern Montana and Bri ish America.

It is impossible to lay down general laws, as the movements of the locusts are as variable and uncertain as the direction of the winds and the condition of the weather in that mountainous country. We have only attempted to give the general facts of the migrations, and find it impossible to lay down absolute laws in the present state of our knowledge.

It would also appear that the region east of the Belt Range, and possibly the Big Horn Mountains, may form a dividing line, east of which the locusts fly east, and west of which they fly west; certainly the Belt Range is not a barrier to their westward flight, although the Bitter Root Range appears to be, deflecting the swarms southward into Eastern and Southern Idaho and Northern Utah.

Wyoming.—This Territory is so thinly settled, and consequently observations on the migrations of the locust so scanty and incomplete, that it is difficult to draw any general conclusions as to the movements of the swarms that breed in such great numbers in the larger river valleys. The most reliable observations tend to show that the swarms fly in a general southeast, sometimes east course. By reference to the arrows

on the third map, which represent actual observations, involving no theory, the fact that the flights are in the main from the northwest will seem to be supported. While some swarms have been observed traveling northward and northeastward, the great majority are reported to travel east or southeast. In 1873 immense numbers flew east through Bridger's Pass. In 1875 vast numbers were observed at Laramie City flying southward and southeastward. Previous to this year Mr. Thomas saw a swarm flying at South Pass a little north of east, and another near Fort Fetterman due east. In August, 1876, Lieutenant Carpenter, U. S. A., and Mr. Strayhorn, saw swarms flying toward the southeast over a large portion of Northeastern Wyoming, east of the Big Horn Mountains and north of the Black Hills, which separated the swarms, the locusts flying in a general southeast course on each side of that group of peaks. At Laramie and Cheyenne the locusts nearly always come from the northwest, and thence fly southward along the base of the Rocky Mountains, passing over Denver. Lieutenant Carpenter is very explicit in his statements that no swarms fly directly south from the Black Hills into Colorado, but that they fly directly southeast into Nebraska.

In the Wind River Valley, in 1876, swarms were seen by Lieutenant Carpenter flying southeast; it would thus seem that probably over most of Wyoming, in 1876, there was a general exodus of locusts toward the the southeast into Nebraska and Kansas, as well as Colorado.

In 1877, July 20, Lieutenant Carpenter observed in the Little Big Horn Valley locusts flying in a northwest course into Montana. These may have originated in extensive hatching-grounds noticed by him about Fort Reno in the late summer of 1876.

Colorado.—This State is so mountainous east of longitude 104° 30′ that the movements of the locusts are uncertain and difficult to generalize. As a rule the injurious swarms are supposed to come from the north and northwest, and sometimes directly across the Rocky Mountain Range from the Middle Park and the Snake and Bear River Valleys.

The observations in Colorado have mostly been made at or near Denver, so that over most of the State the movements of swarms have not been observed.

In 1864 the destructive swarms came from the northwest. In 1867 a swarm from the west side of the range poured into Middle Park. In 1874 the swarms came from the north and west. The next year flights of locusts visited Denver, presumably from the North Park, and at Greeley they came from the north and northwest. Departing swarms usually pass to the south and southeast, and in Texas it is supposed that the foreign swarms came from the Rocky Mountain region of Colorado. Sometimes, however, the swarms pass southwest over the mountains.

Mr. Holly (see Appendix 7) reports that one year, in the upper valley of the Rio Grande, the locusts came from the west across the range in immense numbers. In the Saguache Valley the course of the

flight was northeast across the Saguache Mountains to Lake County. On the main Arkansas River, in Lake County, they fly east. These flights are more or less local and evidently determined by the variable winds in this mountain region. It seems, however, to be a matter of fact that a large proportion of the locusts which devastate the arable portions of Colorado appear late in July and during August, just as the harvest is over, from the northwest and west, and that by the early part of September they reach Texas, and continue to pass across the plains in a general southeast course until early in November.

Eastern Idaho and Utah.—In considering the migrations of the locust in the Upper Snake River Valley and in Utah, we should bear in mind that this region is a southern continuation of Central Montana, this being apparently the main source of the locusts which invade Utah. Our observations in Idaho are quite satisfactory, as on the stage-road from Franklin to Virginia City we were enabled to gather considerable information. From various sources it seems well established that the locusts invariably fly south from the region of Virginia City, past Market Lake and Fort Hall into the Bear River and Malade Valleys. At Franklin we were told that the swarms always come from the north. Mr. J. B. Hunter told us that in driving cattle for a distance of about 200 miles south from Virginia City, swarms of locusts kept moving ahead of him, flying either southeast or southwest, but never in a northward course. At Franklin the parents of the young locusts observed by us early in June were said to have come from a region 200 miles north, namely, Central Montana; they appeared from a point a little east of north in September, 1876. It thus appears that when they are abundant one year in Central Montana, they fly south into Northern Utah, Cache and Malade Valleys and lay their eggs. The young hatching out the succeeding year, or becoming fledged, fly south into the Salt Lake Valley. For example, the locusts which hatched out in Salt Lake Valley were said to be the progeny of those which bred in Malade and Cache Valleys the year previous.

At Logan City, in the Bear River Valley, and at Smithfield. they were observed to come from the north. At Plain City, Weber County, in 1867 they came from the northeast, and departed in forty-eight hours in a southwest direction, which took them over Salt Lake, when by a change of wind many perished in the lake. At Nephi, in Central Utah, and at Saint George, on the southern border of Utah, they arrive usually from the north. For two successive years, according to Mr. Siler, the flights in Southern Utah were to the north; these were probably return flights, the progeny of those which came the preceding years from the north.

MIGRATIONS OF THE LOCUSTS IN THE LOWER SNAKE VALLEY.

The course of the flights in the Lower Snake Valley is mainly, so far as we have been able to learn, in a general westerly direction. We heard

of large numbers of locusts hatching in the spring in the Snake Valley about Boise City, and that swarms appeared, August 2, in the valley of the Bruneau. Three or four days after large swarms appeared about 100 miles southwest of this point in Nevada. The valley of the Jordan River was apparently invaded from the northeast, while the Burnt River Valley was visited from the southeast, the direction of Boise City. The region around Boise, then, appears to be a small center of distribution for swarms moving westward. Of the origin of the locusts which have invaded Lewiston and Patoka Valleys we have no information.

RETURN MIGRATIONS FROM THE BORDER STATES (TEXAS TO MINNESOTA) PREVIOUS TO 1877.

The data on this subject are scanty previous to 1875.

In Texas, in 1858, the young took flight north from the 10th to the 16th of April.

In 1867 the flights out of Kansas early in June were to the west or northwest; while in Missouri they were reported, June 8, as going west and southwest from Saint Joseph; at Kansas City, June 26, millions flew northeast.

In 1869 locusts flew into Andrew County, June 18, from the south, with a strong south wind; on the 23d, a fresh south wind blowing, they rose and went on.

In 1873 Minnesota was visited in June by swarms from the southwest.

The movement out of the States lying south of the 44th parallel of latitude in a general north and northwest course was, in 1875, almost universal. From Texas we have not full data. From Fort Gibson, Ind. T., they departed during the month of May in a generally north and west direction. On one day at the end of May "millions of locusts flew westerly" from Fort Gibson.

From Missouri the flights during the month of June up to the 20th or 25th of June were to the north and northwest. The locusts first took flight in Kansas from the extreme southeast of the infested region, on May 28 and 29, the swarms passing over the State in a northerly and northwesterly course.

Mr. Riley, in his Eighth Report, states that "the testimony of a vast majority of observers is conclusive as to the general northwesterly direction of their flight. The few cases on record of their moving in other directions are attributable to strong adverse winds, or to the fact that they were merely making short aerial excursions preparatory to the grand flight. It was noticed that when they flew to the south or east it was at a much lower elevation than when apparently returning to their native habitat."

Prof. F. H. Snow, of Lawrence, Kans., states that "when the wind is strong they fly with the wind. If the wind is light they fly toward the northwest by what seems to be a natural instinct. Thus, on June 7, with a southwest wind moving, according to the university anemometer,

at the rate of three miles an hour, the locusts were flying in vast numbers in a direction a little to the north of west *nearly in the face of the wind.* On June 12, also, with a northeast wind blowing at the rate of four miles an hour, they were flying in greater numbers than ever before in a northwest course *at right angles to the direction of the wind.*" Having once taken wing, there are on record, adds Riley, but two or three instances of their alighting within the borders of the State.

In Nebraska the locusts left the State between the 7th of June and the 6th of July. The course of the swarms was invariably to the northwest, except during the prevalence of strong adverse winds or absolute calms, and in such cases they commonly alighted to await more favorable winds.—(Riley.) Reports received from Nebraska City state that the flights were to the north, coming from the south, probably Missouri, with a south wind.

According to the observations of Professor Aughey, prepared for the Commission, the first flight of locusts north was over Plum Creek, on the Union Pacific Railroad. At Kearney, May 31, immense clouds of locusts passed over in a northerly direction. June 14, enormous numbers of locusts flew north at the rate of eight miles an hour. The hegira extended from 100 miles east of the Missouri to Kearney. At Lincoln, June 16, locusts were seen going north by the "countless billions"; the wind was from the south, the thermometer 100° F. "The locusts began to rise at 8.30 a. m., and the numbers rising increased all the forenoon. At 12.30 I observed a nimbo-stratus cloud in the zenith, and I could see with my glass that the locusts reached that height. I measured the west line of the university grounds, and with transit quadrant took the angle at each end of this line on the sharp end of this almost stationary cloud. This made the height of the locust-column 5,230 feet, or within 50 feet of one mile. I allowed 50 feet, however, for a rising-space above the surface of the earth. Otherwise the column could have been called a mile thick." As to the size of a swarm observed June 16, Professor Aughey thus writes:

> The column extended to-day from at least 100 miles east of the Missouri to Fort Kearney, and was at least 300 miles long east and west. As it averaged at least one-half mile high, though here it was nearly double that, and continued, in round numbers, from nine to three o'clock, the number of locusts was simply enormous and incalculable. As there were at least 27 locusts for every cubic yard, the number in a cubic mile was 27,878,400. Taking the half of this number and multiplying it by 300, the length of the column east and west, we have 4,151,460,000. Now, as they were as thick as this for at least six hours, and as they moved at least five miles an hour, this number must be further multiplied by 30, which will give 124,543,800,000 locusts which moved this day But, as they were moving much faster and longer, and the column was much higher than in this estimate, the probabilities are that it would be much nearer the truth to double this number for the actual quantity that moved over Lincoln this day. And then it must be further multiplied to cover the extent of country north and south It is somewhat uncertain over what northern and southern area they were moving on this day, but enough is known to justify the further mutiplication by at least four.

The locusts had left the State by June 26.

Serious incursions into Iowa from the States south began to be made about the 10th of June, and lasted from that date till about the middle of July. The western counties of the State suffered considerably from the swarms that were almost constantly passing over, many of which alighted.

Minnesota was also invaded by swarms from Nebraska, Kansas, and Missouri, which deposited their eggs in this State. The swarms take various directions, but still many of them leave the State, passing into Dakota and toward the Northwest. Mr. Whitman remarks in his report as follows on the return migration in Minnesota and the Northwest:

Whether or not it is a general rule that the locusts on acquiring wings seek the direction from which their parents had come in the preceding year (a rule which the experience of Minnesota fails to substantiate), it is certain at least that in 1875 "the main direction taken by the insects that rose from the Lower Missouri Valley country was northwesterly." (Riley's Eighth Annual Report, p. 105.) These swarms were traced by Professor Riley, moving northerly from the end of May through June and into July, and passing various points in Dakota, Wyoming, and Montana.

They passed northward over Bismarck at various times between June 6 and July 15. (Same Report, p. 86.) But a still more definite statement as to the final destination of these northward-moving swarms is found in an editorial of the Winnipeg Standard, of August 19, 1876, entitled "Locust flights." It is there stated that in 1875 "the locusts which hatched in Missouri, Kansas, and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton, and Ellice, covering an area as large as that they vacated on the Missouri River. They were re-enforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River Valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense."

There is, of course, in all this a failure to connect by any direct chain of continued observations the swarms that left the Mississippi Valley in 1875 and those which finally disappeared in the region of the mountains and in British America; still less is it shown that those swarms were the parents of those which are known to have hatched in the same regions in 1876, or even that those which are known to have hatched there were those which descended upon the lower country in July and August. But there is, at least, a strong series of probabilities.

In Dakota locusts which flew from the States to the southeast arrived about the 28th of June, and passed on in a northwest course. On the same date vast swarms passed over Yankton, going in a northwesterly direction; light clouds passed over Sully, Fort Randall, and Springfield, in the same direction and on the same date. At Bismarck locusts arrived from a general southerly direction, and by July 15 had all disappeared, "moving north and west." It would thus appear that in 1875 as in 1877, the return flights from the Southern States, Iowa, Kansas, and Minnesota, in many cases pass over Dakota into Montana, and probably British America.

RETURN MIGRATIONS EAST OF THE ROCKY MOUNTAINS IN 1877 OF THE LOCUSTS HATCHED FROM EGGS LAID THE PREVIOUS AUTUMN.

The facts here stated and the records of flights found in the appendix show clearly that in the region south of Minnesota the locusts, as soon as they acquire wings, are disposed from some cause to move northward. From the time they commenced to fly at Bastrop, Tex., April 19, until the 8th of July, when a swarm was observed at Glencoe, Nebr., moving south, the direction of the flights was, with very few exceptions, northward, varying in a few cases to westward. In Minnesota the case was different, although there were long flights in June to the northwest, yet the rule can scarcely be said to apply here, for the exceptions are too numerous. From the facts heretofore ascertained in reference to their habits this movement was anticipated and predicted. The movements in previous years had already led to the conclusion that by some law governing them there is a tendency in the resulting broods hatched in this visited area to return to the native habitats from which their progenitors came. That the broods of 1875 and 1876 hatched in the area south of Minnesota, did move in this direction is conclusively shown by the data furnished in Mr. Riley's reports for 1875 and 1876, and in the papers on locusts by Messrs. Dawson and Whitman.

As will be seen by examining our circular No. 1, a copy of which will be found on p. 3 in this report, our first and second questions related to the flights of locusts and the direction of the wind at the time These questions have been more generally answered than perhaps any others in the circular, and enable us to give more fully than has ever before been done the movements of locusts east of the Rocky Mountains, and especially in the invaded section, which we have designated the "temporary breeding-grounds."

The past season has been an unusually favorable one for studying the "local flights" or limited migrations, from the fact that these have occurred to an extent hitherto unknown in these border States and adjacent Territories. The amount of material collected for the purpose of solving the various problems connected with these flights is very large, and although it may not suffice to dispel all the mystery connected with them it has enabled us to explain much that has hitherto been a matter of doubt and uncertainty, and to lay down the general laws which govern them.

Strange as it may seem to those who have not carefully studied the characteristics and habits of the species, yet it is true that it is possible in almost every instance to distinguish an invading from a local swarm although moving in the same direction and apparently from the same point. Those who have had considerable experience with them are generally able, from an inspection of the insects alone, to decide with reasonable certainty this point. But there are other and still more important methods of determining it.

It may appear of but little importance to the farmers and agriculturists of Kansas or Nebraska, on whose fields a swarm of locusts has fallen, to know whether they are from the plains of Montana or from the prairies of an adjoining State; but if a careful study of their habits shows it to be a general rule that the invading swarms are always, or nearly always, destructive in their operations, and that the local swarms are seldom injurious, then this knowledge is important.

One object of the Commission has been to study carefully this point for the purpose of ascertaining whether there is any difference in this respect between the invading swarms and those which are local or returning swarms; not only on account of its direct importance to the agriculturists of the invaded States, but also on account of its bearing upon the question of their continued vitality in these States.

Early in the season, when rumors of flying locusts came from the south, the Commissioners in the field were asked to express an opinion as to the result; each, when asked, expressed his opinion without hesitation, and allowed it to be published far and wide: "We do not apprehend any danger from them. In fact this is precisely what the Commission anticipated, and is one of the strongest possible corroborations of the theory held, that these insects can never become permanent residents of this part of the Mississippi Valley."

The result has confirmed to the fullest extent this opinion, and our predictions have been fulfilled in a most remarkable manner. Although from the middle of June to the last of August swarms were constantly moving over Minnesota, Dakota, Iowa, Nebraska, and Kansas, some days covering an area equal to any two of these States, yet in all that time, though visited by myriads after myriads, scarcely a dozen fields in all these States were reported as injured. It may therefore be stated as a general rule, that returning and local swarms do but little injury. It is possible that with a different season the result may be different, but so far as the facts heretofore ascertained are concerned, they point to the same conclusion; therefore, with the experience of the past season added, we are justified in giving this as one general rule in reference to their habits.

And right here we beg leave to call attention to the necessity of studying carefully what, to many, may at first appear as trivial and unimportant. Each law ascertained in reference to this species, whether important in itself in an economic or practical sense, is important as an aid or stepping-stone toward the discovery of other laws.

The discovery of this law in reference to the habits of the different swarms has already been the means of dispelling, in a large degree, the fears the farmers and citizens of these border States entertained in reference to the local swarms. The announcement last season that large swarms had been observed about the middle of May flying northward over North Platte, in Lincoln County, Nebr., sent a thrill of alarm throughout that entire State. The fear of such swarms has now de-

parted. Shortly afterward adverse winds drove back these hordes, or others from the north part of the State, or the neighboring portions of Dakota and Minnesota. The hearts of the Nebraska farmers sank once more. The Commission replied to such as appealed to them at this time, "No 'invaders' have left the Northwest; these are but 'local flights,' and little if any danger is to be apprehended from them." The fear of local swarms, even though they are from the north, is therefore, to a great degree, at least, gone.

We mention these facts here simply as illustrations of the importance of studying carefully every part of the history of these insects.

It has been quite satisfactorily ascertained that no "invading swarms" visited the border States in 1877. That numerous swarms from the north entered or passed over almost every part of the locust area of these States is true, but that none of these were hatched in their native breeding-grounds we think will be clearly shown by what is hereafter stated, and by the record of flights given in Appendix 13.

In reference to "returning swarms," in the sense heretofore explained, the data for 1877 are somewhat incomplete, as but few reports have yet reached us from British America, to which section a portion would be likely to wend their way if intent on reaching their original hatching-grounds; and so far but one or two points in Western Dakota have been heard from. But even without these data there are reasons for believing the return to the native habitats was not so general as was commonly supposed it would be by those who hold that as a rule the resulting broods go back to their native home.

In the early part of the flying-season the departing hordes from that portion of the visited area from Nebraska to Texas, with but few exceptions, moved northward, as it was supposed they would do; but later in the season, with a change of wind, they turned southward, and the flights in this direction were almost as heavy and as long continued as those which had moved northward. As there is satisfactory evidence that these southward-moving hordes were not invading swarms from the Northwest, they must have consisted in a great measure of those which had previously moved northward. That some did pass onward is shown by the reports of northward flights over Bismarck, of swarms alighting in Western Dakota, of flights seen at Cypress Hills, Battleford, and some other points in British America. Yet the fact that none passed to the north of the international boundary east of Bismarck, and that there were such heavy flights southward east of the Missouri, in Da-Dakota and Minnesota, leads to the conclusion that but a comparatively small portion of those hatched in the visited area ever succeeded in reaching their native hatching-grounds. That a considerable portion may have and probably did pass on to the north on the west side of the Missouri, where there are no settlements from which we could receive reports, is more than likely; and the few accounts we have received from this section indicate that such was the case.

For these reasons the movements of the locusts east of the mountains, in 1877, must be largely included in the category of "local flights," in the broad sense, that is to say, flights whose limits are within the visited area or temporary breeding-grounds.

LOCAL FLIGHTS.

As before stated, the past season has been a very favorable one for studying "local flights" or limited migrations, and the means adopted by the Commission for collecting data upon this point have resulted in accumulating a very large amount of material.

We give, in Appendix 13, in an abbreviated form, the answers on this point received from our numerous correspondents, in order that all who desire to do so may have an opportunity of studying this subject for themselves, and thus be able to test the correctness of our conclusions.

In order to give an idea of the amount of material collected in reference to these flights, we give here a summary or rather brief notes of the replies received to our circular No. 1, relating to two days, July 3 and 20, remarking only that the flights from the more Southern States had almost entirely ceased at this season.

In these records the direction of the wind wherever mentioned is to be understood as that *from* which it was blowing; and where flights are mentioned without giving the direction, they are to be understood as going with the wind. The language of the correspondent has been retained as nearly as possible.

Record of flights for July 3, 1877.

DAKOTA.

Yellow Banks, Deuel County: First appearance, only a few going west at noon.
Gary, Deuel County: Fly west.
Medary, Brookings County: Wind south, strong; light swarms go north.
Dell Rapids, Minnehaha County: Wind southeast; quite a number alighted.
Forestburg, Bramble County: Cloudy; none seen.
Rockport, Hanson County: Southeast wind; fly very high, and numerous.

MINNESOTA.

Elbow Lake, Grant County: Wind southeast; considerable number go northwest.
Herman, Grant County: Go northwest on the 3d, 4th, and 5th—most on 4th.
Brandon, Douglas County: Fly west; air full of them.
Burnhamville, Todd County: Some left to west-southwest.
Round Prairie, Todd County: Raised in great numbers and went west-southwest.
Long Prairie, Nicollet County: Wind east; partly clear; fly with the wind, in moderate numbers.
Morris, Stevens County: Began to fly at 9; go west; wind southeast; clear and warm; began to alight about 1 o'clock.
Westport, Pope County: Fly a little south of west; extensive movement; very high.
Fairhaven, Stearns County: Go southwest in great numbers.
Paynesville, Stearns County: Go west very thick; many of ours joined them; many came down, but most of them rose again.

Saint Wendall, Stearns County: Go west; many.

Clear Lake, Sherburne County: Wind northwest; go southeast.

Ortonville, Bigstone County: First seen; a few go west.

Lac-qui-parle, Lac-qui-parle County: Go northwest; immense quantity.

Baxter: Wind little south of east; good breeze; large numbers go northwest.

Montevideo, Chippewa County: Wind southeast; fly very thick northwest.

Dassell, Meeker County: Warm, bright; wind easterly, very light. Locusts went southwest till 1.30; then west. Large swarms rose, and a continuous line passed from 11 to 3 o'clock.

Manannah, Meeker County: Upper flight, west of southwest; lower flight, west.

Corinna, Wright County: Go due south; air seemed full as far as the eye could reach.

Cokato, Wright County: Took flight.

Stockholm, Wright County: Commenced flying to west.

Granite Falls, Yellow Medicine County: Come down in small swarms at 11 o'clock; at 12 rising and filling the air; go northwest.

Beaver, Renville County: During a greater part of the day a swarm as innumerable as the sands of the sea-shore took its flight over this section, going in a westerly direction.

Vicksburg, Renville County: Forenoon cloudy; clear at noon; wind east by southeast; hoppers go with the wind.

Palmyra, Renville County: Go westerly; high.

Brookfield, Renville County: Southeast wind; swarms go west and southwest.

Hale, McLeod County: Wind southeast; immense swarms go with the wind.

Penn, McLeod County: Those that lit on the 1st left, going northwest.

Marshfield, Lincoln County: Go northwest; first swarm seen; light movement.

Marshall, Lyon County: Go west freely, alighting in the evening.

Tracy, Lyon County: Go west; did not alight.

MINNESOTA.

Charleston, Redwood County: Go west-northwest, high, and very fast, from 12 o'clock to 3.30. First flight.

Walnut Station, Redwood County: Small flight to west and northwest, from 11 o'clock to 2.30. A few alighted.

Lamberton, Redwood County: Locusts came in with east-southeast wind.

Cottonwood, Brown County: Go southwest in the forenoon, and northwest in the afternoon.

Linden, Brown County: Wind east on the 3d, 4th, and 5th; took most of them away.

Albin, Brown County: Fly west, wind east.

Saint Peter, Nicollet County: Large flight southwest.

Ridgeley, Nicollet County: Fly west in great numbers; our own go with them.

Currie, Murray County: Fly west.

Windom, Cottonwood County: Fly west, very high.

Butterfield, Watonwan County: Light southeast wind. Locusts commenced passing over; many alighted.

Madelia, Watonwan County: Continuous flight all day to a little south of west. Those of ours that had wings joined them.

Luverne, Rock County: Go a few degrees west of north in considerable numbers.

Kanaranzie, Rock County: Air full; as many come down as leave; alight in the evening and leave in the morning; go northwest.

Township 103, range 47, Rock County: Fly northwest.

Bigelow, Nobles County: Clear; light southeast wind; fly thick from 11 to 4.

Worthington, Nobles County: Fly northwest at noon, quite heavy.

Graham Lake, Nobles County: Large numbers go west, few come down.

Adrain, Nobles County: Some fly, a few alighted.

Delafield, Jackson County: Wind south of east; go northwest mostly; very high; none alighted.

Christiana, Jackson County: Go a little north of west; a few alighted about 3 o'clock

Tenhassen, Martin County: Wind south-southwest in the afternoon, moderate, very warm; fly northwest.

Pipestone, Pipestone County: Go southwest at 10 in the forenoon, none alighting.

Bigstone Lake, Bigstone County: Fly northwest, many alighting.

NEBRASKA.

La Platte Valley: Flying east of north. Heavy rains.

Omaha, Douglas County: Flying very high to northwest at 11 in the forenoon. Wind southeast, clear.

IOWA.

Tabor, Fremont County: Go north and northwest.

KANSAS.

Claytonville, Brown County: Fly northwest; wind south.

Record of flights for July 20, 1877.

DAKOTA.

Walhalla, Pembina County: Light northwest wind; sunshine; fly southeast; not many.

Caledonia, Traill County: north wind for five days past; good many go south; none have passed from south this season.

Yellow Banks, Deuel County: Light northwest winds; warm; a frightful swarm came about 9 a. m.; those that were here joined the flight at once, making a dense swarm from about 40 feet high to as high as the eye could reach. By 11 a. m. the lower ones were from 150 to 200 feet high, and continued much the same to 3 p. m. None alighted.

Gary, Deuel County: Strong wind; fly south in great numbers; very high.

Medary, Brookings County: north wind; clear; immense swarms go south all day; the few scattered on the prairie rise and leave.

Dell Rapids, Minnehaha County: Wind northeast; a great many go southwest.

Sioux Falls, Minnehaha County: Fly south; few alighted as yet. The greatest quantity of hoppers that has yet been seen passed over to the southeast. A few came down about 6 miles south of here, but did no damage.

MINNESOTA.

Moorhead, Clay County: Fly south and southeast very thick.

Audubon, Becker County: Wind north 10 degrees west; air full—highest I ever saw; some stragglers alight.

Detroit, Becker County: Wind northwest; very pleasant; began to fly at 10 a. m., and all we had here left us; an immense quantity passed.

Township 136, range 45, Wilkins County: Wind northwest and very unsteady; hoppers fly; those of our hatch rise that are large enough; they rise most numerously when the wind comes in gusts.

Fergus Falls, Otter Tail County: Commenced flight to southward.

Elbow Lake, Grant County: Fly southeast; wind northwest; more than at any time this season.

Long Prairie, Todd County: North winds; cool and clear; go south thick.

Saint Wendell, Stearns County: Wind nearly north; great numbers fly nearly south; some came down.

Saint Cloud, Stearns County: Fly south in great numbers; a few alight.

Becker, Sherburne County: The last left here; go southwest; good breeze from northwest.

Benson, Swift County; Fly west of south in great numbers; few alight.

De Graff, Swift County: Fly east; none alight.

Lac qui Parle, Lac qui Parle County: Fly south of southeast; thick; wind northwest.

Baxter, Lac qui Parle County: Wind northwest; clear and warm; vast numbers fly very high southeast.

Montevideo, Chippewa County: Wind northwest; no hoppers, scarcely.

Kandiyohi, Kandiyohi County: Good many fly southeast; only a few drop.

Willmar, Kandiyohi County: Many fly southeast.

Manannah, Meeker County: Those that remained after the flight of the 10th few northwest. (?) [It is probable this should be southeast.]

Palmyra, Renville County: Passed over southerly. None seen for two weeks past.

Pipestone, Pipestone County: Wind north; fly thick.

Windom, Cottonwood County: Fly south.

Mount Lake, Cottonwood County: The last passed south at 2.30 p. m.

Madelia, Watonwan County: Fly south; wind northwest.

Butterfield, Watonwan County: From 15th to 20th wind west and northwest; to-day changed to north, and nearly all left; go south.

Saint James, Watonwan County: All left here to-day.

Mankato, Blue Earth County: Millions fly high at 11 a. m.; go south.

Wilton, Waseca County: Large numbers fly south; very few have alighted here.

Waseca, Waseca County: The hoppers in this section arose and flew to south-southwest.

Luverne, Rock County: Immense swarms go south, alighting but rarely, at 12.30 p. m.; fell in small numbers in places to south and east; upper regions filled with hoppers.

Magnolia, Rock County: Large swarms fly south-southwest and southeast, varying with the wind. Many alight in southern part of the county.

Kanaranzie, Rock County: Fly south; largest swarm seen yet; none alighted.

Little Rock, Nobles County: Immense swarms go south; a few cripples fall.

Adrian, Nobles County: Winds north; fly very high and thick.

Worthington, Nobles County: Flying in clouds; few come down in this vicinity. Wind north, tending east; quite a good many fly as near west as the wind will allow.

Bigelow, Nobles County: Wind north; clear; large swarms flew south.

Brownsbury, Jackson County: Immense numbers go south; wind from the north.

Jackson, Jackson County: "Are flying 9 miles deep as we go to press."—*Republic.*

Hunter, Jackson County: Go south; most numerous I have seen this year.

Hector, Renville County: Wind northwest.

Glencoe, McLeod County: Fly very thick southeast.

Penn, McLeod County: A few scattering ones go south.

Benton, Carver County: Great numbers fly southwest; wind from north.

Carver, Carver County: Large swarms fly in a southerly or southwesterly direction; some alight near town.

Shakopee, Scott County: Wind northwest to north; clear; fly in great numbers southeast to south, from 10 to 3.

Marshfield, Lincoln County: Wind north; immense swarm came in sight about 11 o'clock, flying south till sundown.

Marshall, Lyon County: Pleasant; air full; go southeast all day.

Lamberton, Redwood County: Wind from north and northwest. From the 8th till the 20th the flight has been steady and culminated in a grand rush on the 20th; the heaviest flight I ever saw.

Albin, Brown County: Few flying; wind north-northwest; no coupling or laying yet.

Saint Peter, Nicollet County: Very thick, and most of them very high; all go southeast.

Le Sueur, Le Sueur County: Passed over to south in greater numbers than at any previous time; were at a great height, and the sun was almost darkened by the immense mass.

Le Sueur Centre, Le Sueur County: Heavy flight to south; some few dropped near night on some farms.

Waterville, Le Sueur County: All left from all around here and went south; none lit.

Morristown, Rice County: Fly little west of south; more than ever before. Went east in large numbers; most of those hatched here went with them.

Blue Earth City, Faribault County: Clouds fly over, south; only a few stopped in this vicinity.

Winnebago City, Faribault County: "Air full from 9 o'clock a. m. to 6 o'clock p. m. Fly southeast. Began to fly at 9.30 a little east of south, with good breeze—dense numbers as the eye could see. Flew till 3 o'clock."—[*Pioneer Press.* "Alighted quite thick."—[*Despatch.*

Alden, Freeborn County: Left here, and the air was full, thicker than I ever saw before, flying from 11 a. m. to 3 p. m.; wind north-northeast; some commence to couple.

Freeborn, Freeborn County: Began to fly at 11 a. m. Go southeast to east. Air full till 4 o'clock. Some alight, but none leave.

Albert Lea, Freeborn County: Fly south at 11 a. m. Strong wind.

Geneva, Freeborn County: First flight left here in large numbers, to southeast.

IOWA.

Algona, Kossuth County: A large number are said to have alighted around Algona.

Carroll City, Carroll County: Large swarms fly over to southeast for two hours.

Dakota City, Humboldt County: Weather clear, wind northwest. Hoppers fly southeast in afternoon, some alighting.

The record of the 3d contains reports from sixty-five different points, scattered over Minnesota, Dakota, Iowa, Nebraska, and Kansas; that of the 20th, from seventy different points. As a matter of course, the record of each day during the flying season is not so full as these two, yet quite a number embrace as many points, and a few days perhaps more. At the commencement, the reports are few and scattering, and as we approach the close of the season they again decrease in number. During the entire season, something like two thousand reports in reference to flights east of the mountains have been received.

A careful study of the record of these two days here given will reveal several important facts; and as an illustration of our method of using this material, we call attention to some things to be learned therefrom.

That of the 3d, although relating to an area extending from Central Kansas to Northern Minnesota, shows that the flights at all points, except two, were in the direction of the northwest quarter of the compass, varying from north to a little south of west, the variation from a north course being greatest in parts of Minnesota and Dakota. It also shows that in every instance where the direction of the wind is noticed the flight is with the wind; and in one case, at Manannah, Meeker County, Minnesota, where there were upper and lower currents moving in differ-

ent directions at the same time, the movements of the locusts in the different currents corresponded therewith.

At one point, where the day was cloudy, none were seen on the wing. At several points a note is made of the fact that the local brood arose and joined the passing swarm. Where the hours are noted, they show the flight to have been during the middle part of the day, or at least between 9 a. m. and 4 p. m.

Although, as will hereafter be seen, there are exceptions to what here appear to be general rules, yet the rules hold good to a very large extent throughout the entire record, except as to the general direction of the flight, which, as will be seen on the 20th, was southward.

The first flight of the season, of which we have any notice, was at Bastrop, Tex., on the 19th of April,[23] to the north. The first in Indian Territory, of which there is any record, was at Camp Supply, May 23, to the northwest; but as the accounts from this Territory are very meager, it is not at all likely that we have received notice of the first observed. The first noted in Kansas was in Trego County, May 17, to the northwest. The first in Nebraska was at Amazon, Franklin County, May 15, to the north. The first in Minnesota, of which any reliable account has been given, was at Raymond, Stearns County, June 5, to the southeast. The first in Dakota was at Medary, Brookings County, June 9, moving southeast.

A BRIEF SUMMARY OF THE FLIGHTS EAST OF THE ROCKY MOUNTAINS IN 1877, BY STATES.

Texas.—The first flight reported was observed, as heretofore stated, at Bastrop on the 19th of April, moving northward. This was followed by another, on the 25th of the same month. A somewhat general and very heavy flight occurred on the 1st of May, notices of which were received from Calvert, Salado, New Braunfels, Dallas, and Austin. This movement, which is supposed to have carried off most of the locusts hatched during the spring in this State, was also to the north. A few slight swarms were observed after this up to the 10th of May, but the great body of the insects undoubtedly left about the first of the month. In the latter part of August swarms began to return southward; immense numbers were observed at this time passing over Robertson County; others were seen at Bexar, in the latter part of September (28–30), and others at Bastrop, as late as October.

Missouri.—The locusts which hatched in Jasper and adjoining counties in the southwestern part of the State departed toward the north and northwest during the latter part of May and first of June. Those in the extreme northwest section left in the latter part of June and first few

[23] *Since this was written, additional notes have been received from Texas, through the Signal Service Bureau, which may show an earlier date for the first flight. As these are to be found in Appendix No. 3, the reader can easily make the correction, if necessary.*

days of July. It was probably the swarms from this section which were observed about this time in Fremont County, Iowa, moving northward. In August and September swarms were observed passing southward over Holt, Nodaway, Atchison, Jasper, and Barry Counties.

Arkansas.—The only accounts of flights we have received from this State are from Benton County, in which it is stated that in September some swarms passed over from the northwest.

Indian Territory.—We were very desirous of obtaining notices of flights from this Territory, for the purpose of ascertaining whether it was possible to trace particular swarms in their movements, the possibility of succeeding being rendered much more likely in the case of an early swarm, starting from the extreme south and moving north, than at a later date, when the movements became more general. But it was impossible to obtain correspondents in this Territory in the sections where such swarms were likely to be observed. There is some evidence that flights to the north were observed in the early part of May in some portions of the Territory; but it is too indefinite to be of any value, except as showing the direction of the movement. At Camp Supply, locusts were observed moving north on May 23, and at the same place they were seen moving south on the 11th of September.

Kansas.—Flights were observed in Nebraska two days before any movements were noted in this State. The first swarm observed here of which we have any notice was on May 17th, in Trego County, in the western part of the State; this moved north-northwest. Other swarms going northward were observed in Ellis and Labette Counties on the 21st and 23d of the same month. On the 26th and 27th extensive swarms passed northward over the western part of the State which were observed at Kit Carson, Monotony, also in Phillips and Greenwood Counties. On the 12th, 13th, and 14th of June, the large body of those hatched in the State commenced to migrate, and although a large portion moved toward the north, yet this was by no means universally the case. Although the counties in which flights were observed on these days are all in the northeast part of the State and hence in the vicinity of each other, yet the direction of the flights varied from north to southwest, a few going almost directly south at one point. On the 12th, in Saline, they moved northwest, and in Clay, south. On the 13th, the movement was entirely to the west and southwest, except in Brown County, where they went northeast. These we have reason to believe came down in the vicinity of Sioux City, Iowa, in the afternoon of June 14. On the 14th it was entirely toward the north. After this but few flights were observed until in July; at least but few notices of movements have been received by the Commission, which occurred during this time. Between the 18th and last of this month they began to return toward the south. In August there were movements in both directions, but chiefly southward; this was continued at intervals through September.

Nebraska.—A small flight passed over Franklin County as early as May 15, going north; another over Dodge County on the 17th, going

northeast; on the 18th a large swarm was observed at Kearney, going north; on the 26th and 27th very heavy flights passed over Ogalalla and North Platte toward the northwest. After this, until about the middle of June, flights are reported almost daily as passing over some part of the State, chiefly Platte, Colfax, Keith, Phillips, Lincoln, and Butler Counties, generally moving north, but in one or two instances westward. In July, from the 8th to the 15th, occasional swarms were seen passing northwest in the extreme eastern part of the State.

There was really no one general movement of the locusts from this State. South of the Platte they began to move in the latter part of June (25 to 30), and later farther north and east, some not departing until in August.

The movement toward the south commenced early in July, as a report from Mr. Dodge, of Glencoe, Dodge County, dated the 8th, states that "the locusts have been flying a little east of south for several days." Professor Aughey, our assistant for Nebraska, observed what was in all probability the same swarm passing south over Lincoln City on the 9th, flying, as he remarks, "high and in a heavy column." From the 11th to the 14th the movement was northward. On the 15th it was again toward the south, and continued generally in that direction for a week or ten days, and then again changed to the north. From this time until the 5th of August the flights were mostly toward the north, but irregular and variable. About this time (from 5th to 8th) the unusual phenomenon of locust swarms flying in opposite directions at the same time and place was observed on several different days in the area embracing Knox County, Nebraska, Yankton, Dak., and Sioux City, Iowa. Professor Aughey, who had visited this section on behalf of the Commission for the purpose of noting the locust movements, fortunately happened to be in this region at this time, and witnessed this unusual occurrence, which will be more fully noticed and explained hereafter.

After this until the last of September swarms were passing over in various directions, but generally toward the south.

Iowa.—The first flight observed in this State of which we have received any account was on the 14th of June, in the extreme northwest part, between Le Mars, in Plymouth County, and Sioux River. There are good reasons for believing that these came from the northeast corner of Kansas and the extreme southeast corner of Nebraska. It is almost certain that they did not come from any part of Iowa, and it is certain that locusts left Brown County, Kansas, on the 13th. These came down in the vicinity of Sioux City, where they remained some days. Those hatched in the extreme southwestern part of the State commenced leaving Fremont County on the 22d of June. Between this date and July 10 most of those hatched in the State took wing, moving northward. About the middle of July the southward flights commenced and continued, with intervals of northward movements, until September. As will be seen hereafter, the northern or central part of Iowa was prob-

ably the turning ground of the swarms blown back and forth northwest and southeast across Minnesota during the middle and latter part of the summer.

Minnesota and Dakota.—As the flights in this State and Territory are intimately connected, and have been studied together, we will give a summary of them together.

In reference to these our records are very full and complete, owing to the fact that Professor Whitman, who was our assistant for Minnesota, had been studying the locust problem for some years previous to 1877, and had arranged a system of correspondence which enabled him to obtain daily accounts during the flying-season from every locust-visited county in Minnesota, as well as from some of the adjoining counties of Dakota.

The first swarms observed in Minnesota, of which we have any definite account, were seen June 5 in Stearns and Blue Earth Counties flying southeast. On the 9th, swarms were seen in Brookings County, Dakota, and Nicollet, Ramsey, and Benton Counties, Minnesota, flying southeast. On the 14th and 15th, the wind changed, and those from the south began to pass over the southwest corner of Minnesota and southeast corner of Dakota. But even at the risk of being considered somewhat prolix in this part of our report, we will introduce here Professor Whitman's very interesting summary of the flights in this State and Territory:

There was a considerable flight over some of the eastern counties of Dakota about June 10. A very few alighted in Becker County (Audubon) and remained there, and were seen coupling about July 1.

About June 16 and 17 there was a heavier flight northward across some of the southeastern counties of Dakota. At one point it was two and a half days in passing. It also extended, but not heavily, over points in Nobles (as far east as Worthington), Rock, Murray, and Lyon Counties, over Morris and Fergus Falls. Some of these reached the Northern Pacific Railroad, in Dakota, at Worthington, Jamestown, and Bismarck. These two flights were undoubtedly from some southern hatching-grounds.

Our own hatch flew with daily increasing numbers and in various directions from about June 22d to the 26th, 27th, and 28th, on which days there was a quite extensive flight to the southeast. This extended mostly along the Saint Paul and Pacific Railroad and the Minnesota River, but was also extensive over Saint Cloud.

June 29 and 30 were unfavorable days for flying, or rather for observing flights, and the records are fewer.

July 1 was a most favorable day for flying. As the wind was generally very slight and changeable, the directions taken vary a great deal. Reports from forty-one points give flights in nine different directions, some moving in no particular direction, and others moving in opposite directions in different parts of the day.

July 2.—Fewer swarms observed, going generally east and southeast.

July 3.—Flying northwest, west, and a little south of west at forty-eight points. Wind generally light, and swarms flying very high. Movement extensive from the Iowa line to Pope and Grant Counties on the north, and to Marshfield and Ortonville on the west, where flying swarms appeared for the first time.

July 4, 5, *and* 6.—Very nearly a repetition of July 3. The alighting of parts of these westward flights on these four days, from Morris over into Dakota, was stated at the time in the Pioneer Press, and seems to be the only *continued* alighting occurring in any movement that has taken place so far.

July 7.—Wind changing to northwest. Very few flights reported in any direction.

July 8.—Swarms returning, moving generally a little east of south. Movement reported at forty-six points between Otter Tail and Todd Counties on the north; Sherburne, Carver, Scott, and Waseca Counties on the east, and Freeborn, Jackson, Nobles, and Rock Counties on the south.

July 9 *and* 10.—Nearly a repetition of July 8, except that the direction changed more to southwest, the wind changing to southerly on the latter date in many places.

July 11 *and* 12.—Movement reversed again; flying northwest in abundance on the 11th and in still greater number on the 12th. Movement extended from Detroit, Becker County, to Sioux City, on the west.

July 13.—Weather generally unfavorable for observation; flying northeast at a few points.

July 14.—Ditto.

July 15.—Change of wind; flying southeast ina few places.

July 17.—Wind generally northwest; flying southeast in a few places.

July 18 *and* 19.—Wind northwest, generally cool and cloudy, and very few observed.

July 20.—Grand movement; swarms observed at fifty-six points, flying southeast, south and southwest; swarms represented in most cases as extremely large, flying very high; moving from 9 a. m. to 6 p. m. at Winnebago City, and until sundown at Marshfield; seen at various places from Audubon to Sioux Falls on the west, from Saint Cloud to Albert Lea on the east, and at Carroll City, Iowa, on the southwest.

July 21.—Nearly the same, but flying in fewer numbers. Seen at Morristown at 8 a. m.

July 22.—Change of wind to southerly; flying northwest in great numbers at Audubon, Detroit, Moorhead, Marshall, and Worthington.

July 23.—Wind southerly; no heavy flights reported except at Worthington, where they flew very high until late.

July 24.—Wind southerly; few reported.

July.—The wind southerly; flying north very thick over Hector, in Renville County.

July 26.—Wind southerly; few or none reported.

July 27.—Wind changing to northwest; flying at Detroit, in large numbers, a little south of east.

July 28.—Another heavy movement to east and south; reported as moving east at Sioux City, southeast over Rock, Nobles, and Jackson Counties, south at Mountain Lake, southeast over points in Todd and Stearns Counties, and nearly south at Audubon and Crookston.

July 29.—Change of wind; seen flying northwest over Freeborn, Winnebago City, Kasota, Le Sueur Centre, Saint Wendall, and Paynesville (Stearns County), Benson (could be seen till almost sundown), Lac-qui-parle, Moorhead, Audubon, and Crookston; and probably further reports will add many other points where northeasterly movements were seen.

Very few reports have been received since July 30, but they show that a change of wind on July 31 and August 1, to northwest, brought the great flight of August 2 to the southeast.

The alighting between July 3 and 6 has been already noticed; as for any that has occurred extensively since then it is hard to find. On the 8th, 9th, and 10th there was quite a number of places here and there where considerable numbers dropped; since then it has been very light and scattering, and the numbers alighting are very insignificant compared with those that pass along.

To sum up, July 1, the air was thick with locusts over a considerable portion of the State. July 3 to 6, they moved across the State to the northwest, and turning at Morris and westward; on July 8 to 10 crossed the State to the southeast; July 11 and 12, crossed the State to the northwest; July 20 and 21, after the wind had been blowing from the northwest for four days, they crossed the State again to the southeast (and after some return movements to the northwest at various points for a week); July 28, crossed the southwestern corner of the State, again to southeast, and after some flying to northwest; August 2, again crossed the State to the southeast in full force.

Where have been the turning-points of all these movements? Apparently they must have been either in Dakota and Iowa or up in the air. As for Iowa the records of flights will be collected, I presume, by others. As for reports received from Dakota, they do not help the matter much so far. The movements have been nearly the same as in Minnesota, except that they began a day or two earlier. To all appearances, the grasshoppers have spent the greater part of the time in the air since July 10.

The early movements of 1877 (omitting those in Minnesota) therefore coincide precisely with those of previous years, and apparently justify the conclusion that this northward flight is governed by some permanent law, and will, under ordinary circumstances, be the course taken by the broods hatched in the area designated. Whether the facts are sufficient to warrant the opinion, now so generally entertained, that it is a law of their nature to return to their native habitats is another question and a very important one. It may be well, therefore, to present here the pros and cons on the point which we have so far been able to gather by our own observations and study of the species.

1st. We have the fact sufficiently established that in the region designated the first movements of the resulting broods are toward the north or northwest, and in the direction of the section which is now very generally conceded to be the native hatching-grounds of the swarms which visit the border States.

2d. The flights of the resulting broods in Colorado are often westward across the mountains in the direction from which a large portion of the invading hordes which visit that State come.

3d. We have, if not absolute proof, at least satisfactory evidence that in 1875 the departing swarms from a large portion at least of the area designated moved northwest into Eastern Montana and British America, thus reaching the region from which we have good reason to believe their progenitors came.

4th. In 1876 invading swarms from the northwest poured down in vast numbers upon the fields and farms of the bordering States and deposited their eggs over a widely-extended area. In 1877 we see the resulting brood starting back in the same direction as those of 1875, thus apparently forming a biennial cycle in their life-history.

5th. As if led by some mysterious instinct to know that in this climate their progeny will be a degenerate and feeble race, these returning swarms as a general rule refuse, or at least fail, to deposit their eggs in this region.

These are certainly strong arguments in favor of the theory mentioned, yet there are some facts which appear to stand opposed to it, and although it is very plausible, cause us to hesitate before deciding that it has been fully established. This question of migration, especially in its relations to meteorology, will, however, be considered further on in the present chapter and also in Chapter VIII.

SOUTHWARD FLIGHTS IN 1877.

As may be inferred from the data in Appendices 12 and 13, the south-

ward movements in 1877, after the 10th of July, nearly equaled in extent the northward movements prior to that date.

MOVEMENTS IN DIFFERENT DIRECTIONS AT THE SAME TIME.

These are of two kinds—contrary movements over large areas on the same day, and flights in different directions at the same time and place.

It will be seen by inspecting the records given in Appendix No. 13, and even that of the two days heretofore given, that it is no uncommon thing for flights on the same day to vary at different points from northeast and north round westward even to southwest, and likewise in the southward flights from southwest and south around to east. Hence we have throughout considered all movements northeast and around the northwest quarter of the compass to west as northward movements, and those around the southeast quarter of the compass as southward flights. Movements in these opposite general directions on the same day are not so common, yet so far as single points of observation are concerned they are not infrequent, and in several instances occurred in the same or adjoining counties.

Professor Whitman states that on the 1st of July reports from forty-one points give flights in nine different directions. As a rule, these variable flights occur on warm, still days, when there is no general movement of the air in any one direction.

There were a few days in 1877 in which there were movements in different directions over large areas. For example, on the 5th of July, locusts were flying north, northwest, and west (or northward) in Southwestern Iowa, Southwestern Minnesota, and Eastern Dakota, and southward or southeast over a broad belt running northwest and southeast through the middle of Minnesota. The 2d of August furnishes an instance of three different currents, two southeast and one northwest. In Southeastern Dakota and as far east into Minnesota as Nobles County, the movement was to the northwest. Through the central parts of Minnesota and Northwestern Iowa the flights were southward; in Nebraska and Kansas the movement was chiefly to the southwest. At some of the points in Minnesota the flights in opposite directions were quite heavy; in Nebraska they were light and irregular. As a matter of course, the direction of these movements depended entirely upon the direction of the wind, and it would scarcely be worth while to mention them were it not for the bearing they have upon the question of the "return flights."

Flights in opposite directions at the same time and place were not of frequent occurrence, but were occasionally observed. They were always one above the other, and doubtless in different currents of air; sometimes in directly opposite directions, sometimes one column crossing the other obliquely. Those heretofore alluded to as having been observed by Professor Aughey were moving in almost precisely opposite directions, one northward and the other southward, on July 20, 21, 25, and 26, at Dakota City, Nebr.; also, between Yankton and Sioux City

August 6. In reference to the last, he remarks that "the lower current was moving a little east of north in considerable numbers. An equally heavy column was moving toward the south above the one last mentioned.

Our correspondent at Menannah, Meeker County, Minnesota, observed the same thing on the 3d of July.

The correspondent at Tenhassen, Martin County, Minnesota, states that on the 5th of July an upper swarm flew west while a lower swarm was moving northwest very thick. A similar case occurred at Delafield, Jackson County, Minnesota, July 6. Rev. S. R. Riggs, missionary at Sisseton agency Dakota, states in a letter to Professor Whitman that on the 6th of July he "observed that while the surface wind blew pretty strong *from* the south the fliers were moving *toward* the southwest, probably on a counter current higher up."

TO WHAT EXTENT DID THE RETURNING SWARMS IN 1877 PASS ONWARD TO THEIR NATIVE HATCHING GROUNDS?

The direction taken by these swarms in May and June, as heretofore stated, was northward, generally northwest or a little west of north. If the object of these flights was to reach the hatching grounds from which their progenitors came, then to accomplish it they must pass into the Northwest Territory of British America or the northwest part of Dakota and eastern part of Montana, unless the country about the Black Hills of Dakota is found to be a permanent breeding ground, in the sense heretofore explained, which is rendered probable from facts ascertained during the past year. It is impossible to answer this question definitely at present, as but few reports have been received up to this time from British America. Still we may arrive at a tolerably correct conclusion from our own observations and the data we have obtained. Mr. Riley while in Manitoba, during the latter part of August, ascertained that no swarms had visited that province in 1877 up to that time. From Captain Stewart Moore, of Prince Albert Mission, who had just come from Edmonton, Northwestern Territory, he ascertained that locusts flew from the south early in July as far northwest as the vicinity of Battle River. Mr. A. Fuller also reported them some distance north of Battleford. Reports were also received showing that swarms were observed passing northward in the vicinity of Cypress Hills. While these reports show that some did succeed in reaching their permanent breeding grounds, yet the indications furnished by the reports themselves and the absence of other reports leave a very strong impression that this return was insignificant compared with that of 1875, and this impression is deepened into conviction from what we know in reference to their movements south of the international boundary.

Those that left Western Texas about the 1st of May were probably the same that terminated their flight at Black Hills in the latter part of the same month, and there deposited eggs. This supposition is ren-

dered almost certain from the fact that it was between the date of departure from Texas and arrival at Black Hills that swarms were first seen passing over various parts of Eastern Colorado, Western Kansas, and Western Nebraska. It is possible that these composed a part of the swarms which, in the latter part of July, moved northwest from Black Hills into Montana, but it is more likely that these were composed of locusts hatched in this locality. That all which left the country south of Kansas previous to the time those in that State began to move—1–15 of June—did not go to the Black Hills region is evident from the fact that swarms are reported as passing northward over Kearney, Hall, Merrick, Butler, and Dodge Counties, Nebraska, between the 16th and 25th of May. That none of these continued their northward course through Dakota is proved by negative evidence as positively as such evidence will prove anything in a case of this kind.

Letters from the southern part of Dakota, at points along the Missouri, from Sioux City to Fort Randall, state positively that no swarms were seen until 14th to the 16th of June. Farther up, on the eastern border of the Territory, in Brookings County, a swarm or two were seen about the 9th or 10th, but the report leaves the direction uncertain; a small number are reported flying at the same time in Ramsey County, Minnesota, with the same confusion as to direction; on the same day a swarm is reported in Benton County, Minnesota, moving southeast.

The last two are doubtless errors, and those seen in Brookings County, Dakota, were probably moving northeast, as it is certain a swarm came down in Becker County, Minnesota, on the 10th, where they remained until July 1. Mr. Packard returned from Montana by way of the Missouri River and the Northern Pacific Railroad in the latter part of June, reaching Bismarck the 28th. Some swarms were reported as passing northward at some points west of Bismarck, though apparently not very heavy or many in number. The first which passed over Bismarck, so far as he could learn, and as our correspondence shows, was on the 20th, though a large flight was said to have passed over Standing Rock on the 18th, moving westward, which was evidently a part of the great flight that reached Sioux City on the 14th. A part of this flight (which passed Sioux City on 14th June) reached points on the Northern Pacific Railroad in Dakota from 18th to the 20th. None are reported at Fort Totten until in July, and then in small numbers flying over back and forth, north and south, but none of these reached Manitoba or passed into British America. It is certain, therefore, that no part of the earlier flights passed on to British America, Dakota, or Montana, unless they stopped on the way and afterward joined the June flight which left the latitude of Northern Kansas between the 10th and 15th of the month (June). The light column which passed over Southeastern Dakota and moved on to Becker County, Minnesota, probably belonged to the early flight, but, as has been shown, these had proceeded no farther northward up to the 1st of July.

We will now trace the June flights northward in order to ascertain their probable destination, and to see what portion if any succeeded in reaching the native breeding-grounds of the species.

Without stopping to note the various sections from which swarms arose between the 10th and 15th, we may state that our reports show that on the 14th the front of the column moving north had reached the latitude of Sioux City, Iowa, and extended from Blue Earth County, Minnesota, on the east, to Western Kansas on the west. But as none are reported in Nebraska west of Platte County, and an east wind had driven those in Kansas westward on the 12th and 13th, it is probable the advance was in two wings, separated by a broad interval. On the 16th the east wing, somewhat disturbed by a slight adverse wind in the region of the Couteau des Prairies, presented an irregular line, the extreme eastern flank being much the farthest advanced, reaching Otter Tail County, Minnesota, on the 17th, while Southeastern Dakota is reached on the 16th, the western column reaching the Platte River on the same day. As we have already traced the western column to the Black Hills we may omit further mention of it. On the 18th a few reached the Northern Pacific Railroad at Worthington, Barnes County, Dakota, going north, while a heavy flight crosses the Missouri at Standing Rock, moving westward. But in Minnesota the course is changed, and from Otter Tail, in the north, to Brown County in the south, they fly to the southeast; on the following day there was a slight movement toward the west, but so far as the Minnesota section was concerned, from this time forward until the close of the season they flew back and forth, increasing in numbers until July 20, but never reaching farther north than some point between the Northern Pacific and the international boundary.

In Dakota, the return south was a little later, but few passing north of the railroad until we proceed westward to Bismarck. At this point, light swarms passed to the northwest on the 20th and 21st; the flight ceasing on the 22d, when a few came down, and was not renewed again until July 21.

So far as Minnesota is concerned, and also all that part of Dakota east of the couteau of the Missouri, it is quite certain that no swarms of any consequence passed beyond to British America; but that all or nearly all that reached this region from the south in June, returned to the south, died, or were driven off in some other direction. The crossing westward at Standing Rock indicates the passage of a portion of the June flight into Western Dakota, but there is nothing to show or to indicate that this westward movement was general; in fact, all the other reports from Dakota show the movement to have been generally toward the north and northwest.

It is proper to state here that after the 22d up to July 7, while the movements in Minnesota were chiefly to the south, except the northward and westward flights of the 3d to the 6th of July, locusts continued to

fly northward in greater or less numbers in Southeastern Dakota, but none of them reached the Northern Pacific Railroad, so far as we have been able to learn, except a light swarm that came down in Trail County, on Red River.

On the 7th, the wind changed in Central Dakota and blew toward the south, carrying with it those observed moving in that direction in Nebraska on the 8th and subsequent days.

The chief movement of the locusts hatched in Nebraska, in the region of the Platte, occurred between the 1st and 6th of July. The flights were toward the north, but these must have been driven back on the 8th, 9th, and 10th. On the 12th the flights in this State were again to the north and continued in this direction until the 15th, when they again changed to the south, continuing in this direction until the 20th, when the great southern flight occurred over Minnesota, Southeastern Dakota, Iowa, Nebraska, and Kansas. The next day (21st) the flight northward over Bismarck began again and continued until the 28th, when it changed to southeast.

The change in direction from south to north which occurred in Nebraska on the 12th, began in Dakota on the 11th. On the 10th the flights throughout the southern portion of this Territory were toward the south; during the night there was a rain-storm and a change of wind, and on the 11th the movement was toward the northwest, except at Cheyenne Agency, on the Missouri River, where a swarm was observed moving westward. This movement, observed at Cheyenne Agency, corresponds in the direction taken with what was observed at Standing Rock on the 18th of June. Although neither of these flights appears to have been part of a general movement westward, yet they render it quite probable that a portion at least of the swarms which moved northward into Dakota, which could not be traced beyond its bounds in that direction, turned westward on the local currents which are probably flexed here by the Couteau of the Missouri.

A report from "Dog Foot Station" (supposed to be Dog Tooth Station, 30 miles west of Bismarck, on the road to the Black Hills) states that on the 22d of July the locusts were thick there and still coming from the southeast. If this is correct, these may have been the swarms which were seen passing westward at Standing Rock and Cheyenne Agency. But it is quite as probable they were swarms which had moved northwest, on the west side of the Missouri, where there are no settlements or stations from which reports could be received.

Taking all these facts, in reference to the flights, into consideration, and also the additional fact that but comparatively few locusts were hatched in Dakota, from which to recruit swarms moving south, we are led to the conclusion that but a comparatively small portion of the locusts hatched in the States south of Dakota, in 1877, ever succeeded in reaching their native hatching-grounds. While the tendency to return appeared to direct their early movements, this year as in 1875, yet

the attempt to carry out this desire, if it existed, was certainly not pursued with the same determination as in that year. In fact, the flights during 1877 present phenomena not observed in any previous year.

GENERAL DEDUCTIONS.

The facts ascertained by the Commission, in reference to flights east of the Rocky Mountains, together with previously recorded observations, justify us in drawing the following conclusions. Some of these conclusions we are satisfied may now be considered as established rules; the rest are yet uncertain, and are given as what the data ascertained seem to indicate as rules, but which more complete evidence may show to be erroneous.

1. That they seldom migrate except when the atmosphere is in motion; in other words, when there is some wind, and that they move with the wind. The facts ascertained warrant us in giving this as a rule, which has few or no exceptions. It is evident that they depend almost wholly upon the wind to move them, using their wings to sustain themselves in the air; usually turning their heads toward the wind and drifting backward. When the wind is very slight, they usually turn their heads with the wind and aid with their wings in moving onward.

2. That as a very general rule the resulting broods in the Border States and the plains east of the mountains move northward, immediately after acquiring wings, toward the regions from whence their progenitors came; that south of Dakota and Minnesota this appears to be almost invariably the direction of the early flights; that in these (Dakota and Minnesota) and northward, where the insects acquire wings later in the season, the direction of the earlier flights is not so uniform.

3. That at the time they acquire wings south of Dakota, the direction of the wind is usually toward the north or northwest; yet not to such an extent as to entirely govern or explain the locust movements; hence there are strong reasons for believing that there is some other cause for this tendency to move northward at this time.

4. That later in the season, after those in the more northern regions have acquired wings, the direction of the flights is generally southward; the general direction of the wind at this time is also southward, but is by no means uniform or constant.

5. That so far as can be ascertained those swarms moving northward in the early part of the flying season, which reach their native breeding-grounds, do not again return to the visited area; while those which do not reach these, as a general rule, do return southward, often moving back and forth a number of times in the northern section.

6. That these latter swarms, although apparently at the mercy of the winds, appear to confine their movements generally to the area overspread by their progenitors of the previous year, not strictly, but in a broad sense.

7. That such swarms, as a general rule, are not disposed to deposit their eggs in the visited area, and hence usually perish without ovipositing; and also that swarms returning to their native breeding-grounds, although stopping on the way, are not disposed to oviposit until they reach these grounds.

8. That a sudden change of wind or temperature and increase of moisture usually brings down flying swarms.

9. That timber-belts have a tendency to obstruct their movements and limit their migrations.

10. That the eastern limit of their range, as heretofore given, appears to be fixed by permanent laws governing the movements of the species, which, so long as the climatic conditions remain as they are, will prevent further progress eastward.

11. That the insects often fly at night.

12. That they can, and frequently do, fly so high as to be out of sight.

13. That their flights may be continued for several days, over a distance of several hundred miles.

THE CONNECTION OF METEOROLOGICAL PHENOMENA WITH THE MIGRATIONS OF THE ROCKY MOUNTAIN LOCUST.

Anything that can, with our present knowledge, be said on this subject, is necessarily vague and unsatisfactory. That there is an intimate relation between the periodical visitations of the locust and the periodical return of seasons of undue dryness and heat, seems to be probable. That there is an intimate connection between the direction of the wind and the temperature and state of the atmosphere, and the course taken by the locust in its migrations, is also most probable. For example, it is a matter of general observation, that in Missouri, Indian Territory, and Texas, namely, the Western Mississippi States, south of the fortieth parallel, the locusts in August and September come with a northerly, but more usually northwesterly wind from the Rocky Mountain plateau, and in the spring and early summer, when the winds are from the south and southeast, return several hundred miles in a general northwest or northerly direction. This general law seems pretty well established, but in places where the winds are very variable, as in Colorado and in Minnesota, it seems impossible to lay down any general law at present. And in this report we merely propose to state the few facts known bearing on this subject, and leave it for future investigation to confirm or disprove the suggestions we have made.

First, then, as to the recurrence of years of unusual dryness and heat.

The data[24] on which to base any conclusions are very meager. The locust region has been so recently settled that, with few exceptions, no records extend back more than thirty years, and in those exceptions

[24] These data have been collected and arranged for the Commission by Mr. J. S. Kingsley, Salem, Mass.

the data seem not over trustworthy. From the Army Meteorological Register, for twelve years, from 1843 to 1854 inclusive, Washington, 1855, we take the following data:

1843. This year, in Minnesota, Kansas, and Indian Territory, was cold and dry.

1844. Was of nearly average temperature; dry in Minnesota, but wet in Kansas, and to a less extent in Indian Territory.

1845. Was rather warm, moderately dry in Minnesota and Indian Territory, but very wet in Kansas (an error here?). In this year swarms are reported in Wyoming, and Idaho, and Texas.

1846. Was warm in Minnesota; elsewhere moderate; moderately dry in Minnesota and Indian Territory. Very dry in Kansas. There are doubtful accounts of a swarm of locusts in Kansas this year.

1847. Was rather cool and quite dry; locusts were reported in Wyoming this year.

1848. Was of nearly average temperature and rather dry.

1849. Closely resembled the preceding year in temperature, but was everywhere very wet. Locusts are reported in Texas, and doubtfully in Minnesota.

1850. Average warmth; wet in Northern Minnesota; rather dry in Texas, Indian Territory, and Mexico.

1851 was rather warmer than the average. Minnesota and Texas were rather dry. Indian Territory and Southern Kansas more so, while in Northern Kansas the rainfall is 40 per cent. larger than the average. Locusts reported this year in Utah.

1852. Of average temperature. Nebraska a little warmer; Minnesota, dry; Nebraska, Northern Kansas, and Texas, less so; Southern Kansas, Indian Territory, and New Mexico, wet. Locusts reported in Idaho and Utah.

1853. Average temperature. New Mexico, quite warm; Nebraska, wet; Minnesota, rather dry; Indian Territory and Southern Texas more so; Northern Texas, Kansas, and New Mexico of average dryness. Locusts in Montana and Utah.

1854. A warm year. Minnesota, Kansas, Nebraska, and New Mexico, moderately dry; Indian Territory and Southern Texas, wet. Locusts in Utah, Nebraska, and Texas.

The data at command for the succeeding years are exceedingly meagre, being mostly incidental references to the weather in various works, and in the answers to the circulars of the commission.

1855 was very dry, "the driest known for ten years." Locusts are reported from Texas and Utah, and doubtfully from Minnesota and Wyoming.

1856. In Minnesota occurred the only drought known between 1837 and 1862; closely resembled 1876. Locusts are reported in Texas, Kansas, Iowa, Minnesota, Wyoming, and Utah.

1857. A cold backward wet spring in Minnesota. Locusts in Texas, Kansas, Nebraska, Iowa, Minnesota, Wyoming, and Utah.

1860. Drought and hot winds are reported from Kansas. Locusts in Kansas and Utah.

1862. Dry in Minnesota. Locusts in Montana.

1864. Very dry in Minnesota and Kansas. Locusts in Kansas, Nebraska, Iowa, Minnesota, Dakota, Montana, Colorado, Utah, and New Mexico.

1874. The summer dry in Kansas and Missouri. The entire valley of the Republican River suffered from drought and heat, and throughout Nebraska it was the driest and hottest summer for ten years. Locusts reported from Texas, Indian Territory, Missouri, and in the autumn throughout the whole West.

1877. Cold, wet. Locusts (the local hatch) everywhere killed by the wet and cold weather.

The following tables present numerically the temperature and rain-fall data relating to these years:

Variations in temperature and rain-fall from the mean of the six summer months of several years for the stations quoted.

VARIATIONS IN TEMPERATURE.

Stations.	Mean.	No. of years.	Variations for the respective years—											
			1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.
Fort Snelling, Minn	56.5	12	−6.5	−0.2	+2.6	+4.1	−2.1	−0.7	−1.6	−9.0	+3.5	+1.2	−1.1	+2.4
Fort Ripley, Minn	51.9	4	.....	.....	.....	.....	.....	.....	.....	−1.6	.....	±	+0.3	+1.4
Fort Leavenworth, Kans	61.7	12	−4.3	+2.6	+3.6	−1.3	−2.2	−0.5	+2.2	+0.2	+2.0	+1.1	+1.0	+4.9
Fort Kearney, Nebr	59.9	5	.....	.....	.....	.....	.....	.....	−1.8	−2.1	.....	+3.4	−1.0	+1.3
Fort Laramie, Nebr	58.9	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	−1.4	−0.8	+2.4
Fort Towson, Indian Ter	70.3	6	−2.7	+2.1	+0.9	.....	.....	.....	.....	−2.0	+1.5	.....	+0.1	.....
Fort Washita, Indian Ter	70.8	12	−3.2	+2.1	+1.4	+1.1	−1.3	+0.1	+0.3	−1.2	+2.0	−1.5	−1.2	+1.5
Fort Gibson, Indian Ter	69.4	12	−3.7	+0.6	+2.5	−0.3	−2.1	−0.8	−0.4	−0.6	+2.1	±	+0.4	+2.3
Fort Scott, Kans	64.7	10	−4.2	+1.9	+1.0	+1.3	−2.1	.....	+0.1	−0.3	.....	+0.5	.....	.....
Corpus Christi, Tex	77.1	2	.....	.....	.....	−1.5	.....	.....	.....	.....	+1.5	.....	.....	.....
Fort Brown, Tex	78.8	4	.....	.....	.....	.....	.....	.....	.....	−0.3	+0.2	+0.2	−0.3	+0.3
Fort Graham, Tex	73.8	4	.....	.....	.....	.....	.....	.....	.....	−1.1	+1.1	−0.1	+0.1	.....
Fort Worth, Tex	71.8	4	.....	.....	.....	.....	.....	.....	.....	−0.1	+1.0	+0.2	−1.2	.....
Santa Fé, N. Mex	61.0	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	+5.1	−5.1
Albuquerque, N. Mex	64.9	2	.....	.....	.....	.....	.....	.....	.....	−1.8	.....	.....	.....	+1.8

VARIATIONS IN RAIN-FALL.

Fort Snelling	18.67	12	−4.73	−7.23	+1.43	−0.21	−8.01	−0.88	+17.97	+0.47	−2.76	−5.71	−2.06	−1.85
Fort Ripley	19.40	4	.....	.....	.....	.....	.....	.....	.....	+6.27	.....	+0.93	+0.13	−7.31
Fort Leavenworth	19.85	11	−0.46	.....	+3.09	−3.80	−2.55	−0.88	+5.14	−2.26	+8.54	+7.06	+0.22	−3.87
Fort Kearney	21.04	5	.....	.....	.....	.....	.....	.....	.....	+0.94	+0.60	−3.65	+6.56	−2.37
Fort Laramie	20.27	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	−2.76	+5.60	−2.83
Fort Washita	24.72	4	.....	−1.87	−2.63	−0.59	−0.98	−4.76	+20.94	+0.09	−9.25	−0.26	−6.56	+7.90
Fort Gibson	21.39	12	−0.98	+4.37	−3.09	−2.94	−7.97	+2.94	+11.79	−1.81	−7.34	+7.48	−3.07	+0.61
Fort Scott	29.24	10	−0.17	+21.89	+20.56	−11.94	−8.54	−6.53	+3.52	−11.69	−9.46	−1.64	.....	.....
Fort Worth	23.29	4	.....	.....	.....	.....	.....	.....	.....	+1.01	−2.31	+1.17	+0.13	.....
Fort Brown	12.08	5	.....	.....	.....	.....	.....	.....	.....	−6.30	−1.83	+1.97	−4.98	+11.12
Santa Fé	15.19	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	+1.04	−1.05	
Albuquerque	7.42	4	.....	.....	.....	.....	.....	.....	.....	−5.29	.....	+5.63	±	−0.36

As to the periodicity in various meteorological phenomena, "some observations," writes Prof. Elias Loomis, "made in tropical countries, indicate a periodicity in various meteorological phenomena, corresponding to the changes of the solar spots, and some observations made in the middle latitudes seem to point to like conclusions; but in order to establish such a conclusion it is necessary to make a very extensive comparison of observations, since the rain-fall at any one place is affected by so many causes which we call *accidental;* that is, whose law is not understood."

The most extensive collection of observations of rain-fall in the United States was made and published by the Smithsonian Institution in its Contributions, No. 222, March, 1872. Mr. C. A. Schott has discussed those observations with reference to periodicity (page 142), but does not arrive at any positive result.

From a later publication[25] we make the following extracts:

The character of the secular variation in the mean annual temperature, as exhibited on the accompanying plate, is that of a series of irregular waves representing a succession of warmer and colder periods, during which, however, the mean temperature deviates only about one or two degrees, in excess or defect, from its normal value. Irrespective of minor irregularities, which have to some extent been eliminated, some of the single progressions appear quite systematic; thus, for instance, at New Haven, the temperature steadily declined from 1802 to 1817, it then increased till 1827, after which it again decreased, reaching a decided minimum in 1836. These undulations, when compared for a number of stations exposed to similar climatological conditions, approach to parallelism over large tracts of country, and exhibit considerable uniformity in their general character.—(Page 310.)

Thus from Maine to Georgia these waves are of a broad and well-defined shape, as at New Haven; but they become somewhat changed in their appearance over the vast area watered by the Mississippi and its tributaries. Here the modulations become more narrow and numerous, as at Fort Snelling. * * * On our west coast, as might have been expected, a new feature is developed, subject, perhaps, to less irregularities than in any other part of the country. * * *

The degree of parallelism of the curves is sufficiently close to warrant an additional consolidation of results for a few characteristic stations, for further study; one typical curve will be given for the Atlantic coast, and another for the Mississippi Valley.

The first is composed of the long series of mean annual temperatures at Brunswick, Me.; Salem, Mass.; New Haven, Conn.; and Philadelphia, Pa., to represent during ninety-one years the type of the secular change for those Eastern States which are situated between the Atlantic and the Alleghany Mountains. * * * (Page 311.)

The second type curve is made up from the stations: Fort Snelling, Minn.; Muscatine, Iowa; Fort Leavenworth, Kans.; and Fort Gibson, Ind. T. * * * (Page 313.)

The distinguishing features * * * of these two type curves appear well marked. The longer waves of the Atlantic stations show: Principal maxima in 1802, 1826, 1846, 1865, and principal minima in 1785, 1816, 1836, 1857; the average interval being about twenty-two years. The shorter waves of the interior States show: Principal maxima in 1827, 1833, 1839, 1845, 1854, 1860, and principal minima in 1831, 1836, 1843, 1848, 1856, 1867; the average interval being about seven years. These undulations, however, are not sufficiently regular or sufficiently distinct, being mixed with subordinate fluctuations, to serve as a basis of prediction; all that can be claimed for them is a general exponent of the character of the secular change.—(Page 314.)

For the purposes of comparison and study we give also the following tables of meteorological data, for which we are indebted to the Chief Signal Officer of the Army, and which relate to the recent years, for which we have also abundant information as to the locust invasions:

[25] Tables, Distribution, and Variation of the Atmospheric Temperature in the United States. * * * By Charles A. Schott. Smithsonian Contributions to Knowledge, Vol. XXI, No. 277, 1876.

Meteorological data afforded for this report by Brt. Brig. Gen. A. J. Myer, U. S. A., Chief Signal-Officer.

Station and month.	1871.				1872.				1873.				1874.				1875.				1876.			
	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.
BISMARCK, MONT.																								
January	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	—8.89	49.11	N	6468	7.92	53.6	NW	5319.3
February	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	—5.87	59.25	N	5715	4.85	59.99	NW	5461.1
March	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.29	59.94	SE	7512	13.06	56.75	N	6247.3
April	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	33.95	65.65	NW	8549	40.3	48.63	NW	6571.1
May	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56.13	60.33	S	7480	56.0	51.6	SE	6240.5
June	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60.88	60.87	E	6186	61.4	50.08	NW	6989
July	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	69.30	48.90	NE	5973	70.3	53.96	NW	5507.5
August	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	66.24	59.57	NW	5727	68.0	59.16	NW	6664
September	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56.10	59.36	NW	5517.7	.....	.....	.....	.....
October	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41.3	51.9	N	6203	42.73	63.06	NW	7598.8	.....	.....	.....	.....
November	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18.1	63.2	N	5742	17.15	61.51	NW	6109.2	.....	.....	.....	.....
December	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.58	57.59	N	5884	20.08	61.21	NW	5801.5	.....	.....	.....	.....
BRECKENRIDGE, DAK.																								
January	.....	.....	.....	.....	.....	.....	.....	.....	2.3	.....	NW	11030	2.6	80.1	SE	11285	—9.48	81.85	NW	6437	6.35	53.18	SE	10053
February	.....	.....	.....	.....	.....	.....	.....	.....	8.6	.....	SE	10080	4.2	78.2	SE	9946	—7.94	80.21	NW	6889	4.3	77.5	NW	10574
March	.....	.....	.....	.....	.....	.....	.....	.....	16.4	.....	SE	11779	15.1	80.2	NW	11293	14.69	82.55	SE	11906	10.5	79.0	N	10118
April	.....	.....	.....	.....	41.0	.....	NW	.....	35.0	.....	N	9550	34.0	72.4	SE	9058	36.13	76.38	NW	8969	38.27	71.85	NE	10409
May	.....	.....	.....	.....	53.0	.....	SE	10074	52.0	.....	SE	7676	60.2	60.6	SE	9081	55.97	64.89	SE	8065	56.32	54.46	SE	10418
June	.....	.....	.....	.....	65.0	.....	SE	7530	69.5	.....	SE	7259	65.9	76.7	SE	8961	60.79	77.69	SE	8176	63.12	61.98	NW	10769
July	.....	.....	.....	.....	67.1	.....	SE	5710	67.6	71.0	SE	7146	70.2	71.8	S	6084	67.69	69.53	N	.....	70.92	64.26	SE	9993
August	.....	.....	.....	.....	65.1	.....	SE	5905	67.0	80.0	SE	7504	67.8	77.9	SE	5708	64.76	75.37	SE	6439	67.65	71.21	SE	11323
September	.....	.....	.....	.....	58.3	.....	SE	7435	49.1	75.0	NW	7522	57.7	71.4	S	6499	55.4	78.9	NW	.....	.....	.....	.....	.....
October	.....	.....	.....	.....	45.0	.....	SE	8810	38.2	66.8	NW	8734	43.8	74.5	NW	7650	42.04	67.9	N	7490	.....	.....	.....	.....
November	.....	.....	.....	.....	21.0	.....	NW	9390	23.4	78.3	N	8764	21.4	81.7	NW	6923	18.31	74.77	SE	8463	.....	.....	.....	.....
December	.....	.....	.....	.....	0.4	.....	NW	8620	8.0	83.3	SE	7889	12.8	83.9	NW	7415	18.05	79.14	NW	10914	.....	.....	.....	.....

Meteorological data afforded for this report by Bvt. Brig. Gen. A. J. Myer, U. S. A., Chief Signal-Officer—Continued.

Station and month.	1871.				1872.				1873.				1874.				1875.				1876.			
	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.
CHEYENNE, WYO.																								
January	.....	...	.....	.....	26.6	....	NW	8743	24.6	.....	NW	8905	30.4	46.6	W	9239	12.5	66.3	W	8485	23.8	58.0	W	.....
February	.....	...	.....	.....	30.9	.....	W	8659	25.0	.....	W	7420	22.9	52.6	W	6028	25.6	63.2	W	9057	30.7	44.6	W	11531
March	.....	...	.....	.....	33.0	.....	NW	6935	39.7	.....	W	9313	28.9	55.2	W	6023	24.3	62.6	W	11984	25.8	65.6	NW	10100
April	.....	...	.....	.....	38.3	.....	W	8639	34.4	.....	NW	8015	39.0	50.3	W	6130	36.9	60.6	NW	11112	42.4	44.8	W	10043
May	.....	...	.....	.....	52.0	.....	N	7300	49.2	.....	W	6465	56.6	42.4	W	7588	54.7	42.5	W	9780	50.6	55.6	W	9259
June	.....	...	.....	.....	51.5	.....	W	6660	69.5	.....	W	5266	65.2	39.5	W	6408	63.7	32.7	W	9332	60.8	39.1	W	7878
July	.....	...	.....	.....	64.5	.....	W	6675	69.7	39.6	W	5584	71.8	43.4	S	6521	64.0	58.4	S	6694	72.3	35.0	S.	8486
August	.....	..	.....	.....	65.1	.....	W	5786	69.2	43.1	W	5548	68.6	39.2	W	6621	63.2	52.0	NW	6382	66.5	38.0	NW	7870
September	59.0	..	NW	5560	55.6	.....	NW	5975	55.9	38.4	.....	5437	54.2	42.5	W	7374	56.0	57.3	NW	6425	.....	.....	.....	.....
October	46.0	...	W	8004	45.2	.....	NW	4973	42.5	47.0	W	6390	46.7	58.2	NW	6704	47.9	40.4	NW	8469	.....	.....	.....	.....
November	28.9	...	NW	7940	28.2	.....	W & NW	8276	40.1	39.2	W	7010	35.8	51.8	W	9215	30.3	62.9	W	7539	.....	.....	.....	.....
December	28.0	...	W	9830	23.4	.....	W	6306	27.6	54.1	W	5753	29.1	52.9	W	8618	33.4	51.4	NW	4049	.....	.....	.....	.....
COLORADO SPRINGS.																								
January	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30.3	47.0	NW	5306	19.1	63.7	SE	5529	28.22	39.48	N	5133
February	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25.5	63.0	N	4402	29.2	73.44	SE	4126	34.97	35.21	N	5271
March	.....	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	34.5	50.0	SE	5614	30.43	53.45	N	5984	33.5	45.3	N	7522
April	.....	..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	38.5	54.0	N	5012	41.57	53.56	N	6894	46.5	40.2	SE	6553
May	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	58.6	40.0	N	5933	57.3	45.3	S	5623	54.9	45.1	SE	6938
June	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	68.9	38.0	S	6097	67.86	42.26	S	6119	64.0	43.4	N	5792
July	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	73.2	43.0	NW	5464	64.6	68.3	SE	4483	72.0	47.8	N	5479
August	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	70.3	43.0	NW	4701	65.3	63.4	N	4237	.....	.....	.....	.....
September	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56.7	46.0	SE	5307	57.9	64.4	N	4407	.....	.....	.....	.....
October	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49.9	50.0	SE	5152	51.3	48.0	N	4583	.....	.....	.....	.....
November	.....	...	.....	.....	.....	.....	.....	.....	37.4	42.6	N	.....	37.9	45.5	SE	5137	37.1	55.9	SE	4440	.....	.....	.....	.....
December	.....	...	.....	.....	.....	.....	.....	.....	42.7	42.7	N	4030	28.1	54.9	N	4428	35.4	44.0	N	5679	.....	.....	.....	.....

DAVENPORT, IOWA.																							
January					23.0		WSW	8412	17.1		NW	6104	23.7	82.6	W & NW	5806	9.4	83.5	W	5591	29.79	75.52	SW	7917
February					27.8		NE	6884	24.9		NW	6511	25.9	83.0	W	5429	10.9	86.0	W	4805	29.93	70.52	NW	7117
March					33.3		NW	6730	36.7		NW	9544	34.7	74.5	NW	8469	30.4	78.8	W	6706	32.17	73.61	NW	8185
April					50.9		SW	8425	46.9		SW	6645	41.6	64.8	NE	7752	46.3	60.5	W	7485	51.16	59.05	SW	8917
May					61.5		NW	7020	59.6		NE	5922	64.5	54.2	SW	7873	60.9	61.9	E	6535	62.41	63.03	SW	6315
June					73.2		SW		77.9		SW	4486	73.2	68.3	SW	6126	68.6	71.4	NW	5444	69.43	70.91	SW	6320
July					76.3		NW	4580	75.6	63.0	SW	4711	78.0	63.9	SW	5841	74.0	73.3	E	3770	75.89	69.61	SW	4804
August					74.6		SW	4860	78.0	57.0	SW	4426	74.4	67.5	E	5844	69.89	69.01	S	4518	74.94	68.43	SE	4611
September	61.4		SSE	5050	64.6		SW	6530	62.3	62.1	SW	631.1	65.5	74.0	SW	5115	61.7	70.47	SW	5017				
October	54.4		SW	6960	52.1		NW	4920	44.3	61.5	NW	5986	52.5	70.8	NW	5654	48.85	62.21	SW	6851				
November	33.6		ENE	6445	32.9		W	6453	34.6	72.6	NW	6532	36.4	74.8	NW	6569	33.51	67.69	NW	6248				
December	20.5		WSW	6159	18.7		NW	6540	29.7	82.0	NW	6719	27.9	81.8	W	5854	34.54	75.62	NW	7172				
DENVER, COLO.																							
January					23.8		S	3696	30.0		NW	4720	31.5	51.5	S	4576	16.79	56.3	N	4121	28.3	40.5	SW	3389
February					33.7		S	4660	30.3		N	3556	24.7	63.9	S	2884	32.25	46.6	NE	4146	37.7	38.77	S	4519
March					36.32		S	5057	44.0		S	5318	36.4	59.6	NE	4238	33.44	48.4	SSW	6150	34.42	52.69	N	5825
April					46.16		N	6276	39.88		N	4764	43.1	54.4	S	4309	44.53	46.8	N	5435	49.34	38.96	S	5071
May					57.7		N	3879	53.31		NE	3744	61.9	41.6	S	6159	60.23	38.42	S	5038	57.06	42.07	N	5193
June					67.28		S	3915	68.93		S	4193	70.0	41.1	S	5022	70.37	28.0	S	4656	65.85	36.63	S	4382
July					69.28		S	3314	71.46	45.0	S	4213	76.1	42.2	S	4832	68.07	55.67	S	4160	76.40	38.63	S	4251
August					69.70		S	3246	70.85	42.0	S	3793	73.0	41.3	S	4349	68.56	46.67	S	3887	70.08	42.30	S	4132
September					60.05		S	3034	59.70	45.0	S	3204	59.0	43.7	S	4144	61.7	51.3	S	3742				
October					50.03		S	2962	45.21	51.0	S	3855	52.9	54.5	NE	3889	54.14	31.45	S	3737				
November					32.51		S	3586	40.6	44.0	S	4431	42.2	42.7	S	5311	37.3	59.8	S	3104				
December	29.12		S	5193	27.60		S	2633	22.4	59.0	S	3032	29.7	56.5	S	3732	37.8	43.8	S	4253				
DODGE CITY.																							
January																	13.2	63.8	N	5126	35.3	55.7	S	7714
February																	29.8	72.3	NW	4098	41.5	48.1	W	9236
March																	58.1	59.8	N	8242	34.7	73.2	N	11571
April																	47.9	63.9	N	9118	56.6	59.3	N	10323
May																	65.4	62.7	N	8201	64.5	58.9	E	12010
June																	75.4	58.5	S	8269	71.2	51.6	SE	11333
July																	75.5	67.1	NE	6766	79.6	62.1	SE	11311
August																	74.6	66.6	S	6021	77.2	64.1	S	11196
September																	68.7	62.7	S	6462				
October													60.7	55.3	NW	5057	56.6	52.9	SW	6491				
November													38.4	60.4	NE	3110	39.9	53.0	N	8627				
December													34.2	67.4	S	3188	40.7	58.4	W	7565				
FORT GIBSON.																							
January													39.5	71.1	E	7068	27.7	68.7	N	4855	45.4	65.3	SE	6441
February													41.3	69.3	E	5564	38.7	62.2	S	6591	47.6	57.8	SE	7354
March													52.2	65.7	E	7109	47.7	57.3	SE	8902	44.4	62.8	SE	9540
April									56.2		SE	8670	53.0	62.2	N	8361	56.7	56.8	NW	7486	63.4	53.7	SE	7356

Meteorological data afforded for this report by Bvt. Brig. Gen. A. J. Myer, U. S. A., Chief Signal-Officer—Continued.

Station and month.	1871.				1872.				1873.				1874.				1875.				1876.			
	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.
FORT GIBSON—Con'd																								
May	.....	.....	.....	.....	.....	.....	.....	.....	67.6	.....	E	6312	70.3	63.8	SE	6718	67.6	68.1	SE	6305	69.6	65.8	SE	6286
June	.....	.....	.....	.....	.....	.....	.....	.....	70.6	.....	SE	4248	73.6	67.9	SE	5471	77.8	68.0	S	6162	73.6	69.9	W	5861
July	.....	.....	.....	.....	.....	.....	.....	.....	80.7	67.0	SE	5138	83.1	61.2	SE	4557	80.0	75.0	S	4385	81.0	72.0	E	4057
August	.....	.....	.....	.....	.....	.....	.....	.....	78.8	61.9	E	3358	86.1	48.4	E	5630	74.6	75.7	SE	3763	81.4	67.6	SE	4460
September	.....	.....	.....	.....	.....	.....	.....	.....	70.2	69.6	SE	5390	71.5	67.9	SE	5265	.....	.....	.....	.....	.....	.....	.....	.....
October	.....	.....	.....	.....	.....	.....	.....	.....	56.9	61.9	E	5410	60.9	65.5	SE	4299	57.7	61.5	SE	5258	.....	.....	.....	.....
November	.....	.....	.....	.....	.....	.....	.....	.....	49.8	58.3	NW & E	11335	50.7	68.7	SE	6685	49.4	64.0	N	5948	.....	.....	.....	.....
December	.....	.....	.....	.....	.....	.....	.....	.....	40.6	75.7	E	6139	43.4	73.0	SE	5659	48.4	61.2	S	6325	.....	.....	.....	.....
FORT SULLY, DAK.																								
January	.....	.....	.....	.....	.....	.....	.....	.....	9.6	.....	NW	6160	16.1	61.6	NW	6758	0.1	61.9	NW	6948	18.7	64.67	NW	7128
February	.....	.....	.....	.....	.....	.....	.....	.....	14.7	.....	E	6500	20.3	63.9	SE	5932	4.2	65.3	NW	6818	14.4	76.0	NW	7356
March	.....	.....	.....	.....	.....	.....	.....	.....	32.4	.....	NW	9310	27.7	59.1	NW	8603	22.3	73.4	SE	9078	15.9	78.3	N	9365
April	.....	.....	.....	.....	.....	.....	.....	.....	41.5	.....	NW	10590	43.9	41.5	NW	8081	39.2	66.1	N	9265	.....	.....	.....	.....
May	.....	.....	.....	.....	58.3	.....	NW	8110	54.5	.....	E	9200	64.2	51.3	SE	9152	60.1	59.7	NW	7638	61.7	53.2	SE	9761
June	.....	.....	.....	.....	70.3	.....	SE	8259	74.2	.....	SE	6309	70.2	63.2	SE	7652	66.0	59.7	SE	9312	68.1	52.0	NW	9332
July	.....	.....	.....	.....	73.5	.....	SE	7425	74.3	49.0	SE	9010	79.2	40.7	SE	8074	73.9	54.7	SE	6189	75.6	58.6	SE	1.173
August	.....	.....	.....	.....	72.2	.....	SE	8720	75.5	51.6	LSE	9446	76.1	49.1	SE	8830	71.4	51.2	N	7887	73.1	60.7	SE	8476
September	.....	.....	.....	.....	62.4	.....	NW	8810	57.3	46.8	NW	7806	65.2	39.7	SE	7152	61.3	54.93	N	6753	.....	.....	.....	.....
October	.....	.....	.....	.....	52.3	.....	NW	6930	42.1	53.2	NW	8546	59.9	49.4	SE	7290	48.9	53.22	S	7937	.....	.....	.....	.....
November	.....	.....	.....	.....	24.5	.....	NW	8160	35.1	57.2	NW	6370	25.2	67.6	NW	6438	24.4	63.32	NW	7968	.....	.....	.....	.....
December	.....	.....	.....	.....	11.5	.....	E	6990	14.9	62.9	NW	5197	26.9	62.8	NW	6579	27.0	73.62	NW	6605	.....	.....	.....	.....
KEOKUK, IOWA.																								
January	.....	.....	.....	.....	25.8	.....	W	6593	17.6	.....	W	5464	27.8	79.7	NW	6610	16.7	76.3	NW	6337	34.1	73.2	NW	7922
February	.....	.....	.....	.....	30.4	.....	SE	4827	26.1	.....	NW	5018	29.4	79.7	N	5249	18.1	71.6	NW	5955	35.0	67.6	NW	7670

March					35.0		NW	6230	38.7		NW	7676	38.3	70.5	N	7674	34.1	68.9	SE	7452	34.9	72.8	NW	8016
April					53.9		NW	6971	48.5		NW	7181	44.6	63.0	NNE	7681	49.5	60.3	W	7441	53.0	59.4	SE	8827
May					64.5		W	5925	61.5		E	7026	67.2	58.3	S	6608	62.9	62.5	SE	6940	63.9	62.5	S	6852
June					75.2		S	4427	77.9		SE	4338	76.7	69.3	SW	5145	71.4	72.2	SE	5545	70.1	72.4	NW	6.04
July					78.6		NW	3716	76.3	68.4	SE	4583	80.5	60.9	SW	4114	76.3	75.8	SW	3546	76.5	74.0	E	5059
August					77.3		S	4117	78.7	59.2	SW	3596	76.8	67.9	E	4979	71.6	70.5	S	4009	76.2	71.5	S	4842
September	63.4		NE	4333	68.2		S	5341	63.9	65.8	NW	5976	67.1	76.0	S	4651	64.3	68.6	S	4819				
October	57.3		S	5477	55.5		SW	5064	49.8	66.9	NW	5424	55.7	68.2	NW	5215	51.1	62.1	SW	5583				
November	36.5		NW	5684	34.6		W	5157	38.9	66.3	NW	6753	40.2	67.7	S	6933	35.3	67.0	N	5694				
December	25.8		NW	6474	20.5		NW	4276	32.0	79.6	W	6424	31.6	77.4	NW	5931	36.5	77.6	NW	6240				
LEAVENWORTH, KANS.																								
January					25.0		NW	5533	19.0		N	5147	28.4	67.0	S	2960	16.7	69.5	NW	4812	35.4	71.0	S	6534
February					30.9		NW	4301	30.0		NW	5614	28.8	72.3	S	4243	22.3	74.5	NW	4626	38.3	60.5	S	7126
March					37.0		NW	6068	42.1		S	8047	40.0	70.4	N	5924	37.6	60.2	NW	5731	35.16	72.6	NW	7862
April					56.2		SW	6595	48.6		N	7804	49.0	62.1	N	6280	49.8	55.2	NW	5640	55.24	60.9	S	7025
May					65.6		SW	5174	63.0		S	5442	67.3	60.0	S	5632	65.8	57.6	S	5644	65.5	64.9	S	6475
June					77.2		SW	5411	75.5		S	4468	77.4	69.5	S	4872	76.7	58.8	S	5778	71.2	66.0	S	
July					78.4		SE	3051	77.5	61.0	S	4902	82.8	59.5	S	4698	77.6	73.7	S	3401	78.9	69.7	S	3440
August					78.4		SE	2839	79.2	54.6	S	3869	81.3	56.0	S	4522	74.1	69.5	S	4223	78.2	69.8	S	3226
September	66.7		E	3662	67.7		SW	4423	65.4	58.0	S	5672	66.8	70.0	S	4296	66.6	66.8	S	4298				
October	56.9		W	4787	56.4		SE	3537	56.9	50.7	S	6040	57.0	67.0	S	4271	53.6	59.8	S	5215				
November	38.0		NW	4896	35.0		NW	6569	41.8	54.3	N	6095	40.0	65.8	S	5758	37.3	62.2	N	5223				
December	24.2		NW	5253	21.0		N	5199	31.9	68.0	N		32.7	70.8	S	4442	39.9	68.0	S	5522				
NORTH PLATTE, NEBR.																								
January																	7.41	70.01	NW	5493	23.6	65.0	SW	4110
February																	21.31	72.68	NE	5000	32.4	54.8	NW	5166
March																	33.19	61.36	NW	8254	27.9	68.2	SE	6607
April																	42.17	66.16	NW	7004	50.3	53.5	SE	7563
May																	61.32		SE	7601	59.6	57.5	SE	7978
June																	69.92	56.69	SE	6954	67.9	42.9	N	7333
July																	72.5	66.4	NE	3518	76.3	53.9	SE	12243
August																	71.7	59.2	SE	4797	72.8	58.9	SE	11239
September																	62.5	60.0	SE	4643				
October													52.4	64.5	NW	5683	53.4	55.4	NW	4991				
November													35.7	58.9	SW	6230	31.5	67.8	SE	4479				
December													28.3	70.1	NW	5044	34.0	64.3	NW	4294				
OMAHA, NEBR.																								
January					19.0		NW	6000	16.9		N	6424	22.3	78.1	S	7447	16.1	75.9	NW	7438	26.8	73.7	S	7317
February					27.5		NW	4045	26.9		NW	5815	23.4	78.7	NNW	4792	13.8	85.5	N	6904	30.1	66.1	NW	8359
March					31.0		NW	5160	38.2		S	8895	33.8	70.7	N	6746	30.5	72.6	NW	9353	29.3	80.0	NW	7683
April					51.0		SE	5820	44.2		NW	8586	45.1	55.5	N	6838	45.4	60.0	N	8290	51.3	62.7	S	7853
May					61.0		SSE	4850	59.0		N	6556	66.6	54.8	S	7801	63.2	58.4	SE	7134	63.6	61.6	S	7935
June					72.7		SSE	4645	74.4		S	5623	73.2	68.8	S	7074	71.1	70.9	S	6229	68.6	63.7	N	7156
July					77.0		SE	3958	75.7	74.2	S	6074	80.0	60.9	SSW	6084	74.4	75.3	SE	4246	75.1	74.1	S	5605
August					75.6		SSE	4521	71.1	72.7	S	4687	77.3	63.8	S	5137	70.2	74.5	S	6350	75.4	73.7	S	5516
September			SE	4250	62.8		SE	5244	60.6	64.2	S	6209	63.0	71.8	S	5696	62.9	74.6	S	5958				

Meteorological data afforded for this report by Brt. Brig. Gen. A. J. Myer, U. S. A., Chief Signal-Officer—Continued.

Station and month.	1871.				1872.				1873.				1874.				1875.				1876.			
	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movement.	Mean temperature.	Mean relative humidity.	Prevailing wind.	Total movements.
OMAHA, NEBR.—Con.																								
October	52.4	..	SE	5540	53.0	.....	S	4282	48.5	62.4	NW	7671	54.0	63.8	N	6435	49.6	66.5	S	7611	.....	.....	.....	.....
November	31.0	..	NW	6521	30.6	.....	NW	6798	38.5	58.0	NW	8112	36.0	64.8	N	7994	32.6	70.4	N	7313	.....	.....	.....	.....
December	16.0	..	NW	5651	19.0	.....	N	5874	25.2	80.8	NW	6199	28.4	74.6	S	6905	33.5	69.8	NW	6737	.....	.....	.....	.....
SAINT PAUL, MINN.																								
January	15.9	...	.....	.....	15.1	.....	NW	3650	6.7	.....	NW	5917	13.8	74.8	SE	6747	−2.35	75.04	SW	5151	16.59	74.02	NW	5880
February	22.3	...	.....	.....	20.3	.....	SE	5250	14.3	.....	SW	5438	14.4	73.0	SE	4189	−1.76	70.92	NW	55·9	17.38	73.35	NW	6258
March	32.0	...	.....	.....	21.9	.....	NW	4930	26.7	.....	NW	7100	23.7	70.4	NW	7585	22.00	75.93	SE	6968	24.26	72.78	NW	6169
April	54.4	...	.....	.....	45.1	.....	SE	6920	41.9	.....	NNW	5192	37.5	55.6	N	6840	30.75	61.01	NW	6879	43.93	56.58	NW	7286
May	64.0	...	.....	.....	55.2	.....	W	7120	55.1	.....	N	5678	62.2	52.6	N	7899	58.81	53.97	SE	6724	59.16	58.99	SE	6800
June	67.4	...	.....	.....	67.9	.....	SE	5980	73.0	.....	SE	5935	68.7	71.2	SE	6889	63.59	67.58	SE	6735	66.27	65.09	NW	6604
July	71.3	...	.....	.....	71.2	.....	S	4610	71.0	68.7	SE	4944	74.7	66.5	SE	6004	73.81	63.93	NW	4531	.....	.....	SE	5141
August	68.5	...	.....	.....	69.2	.....	S	5480	70.7	72.9	SE	5125	70.5	73.4	SE	5833	66.6	70.98	SE	5632	69.9	71.8	SE	5992
September	61.6	..	SE	4575	57.6	.....	.....	6241	54.1	83.3	NW	6749	6 .9	72.8	SE	6397	57.24	74.59	SE	4864	.....	.....	.....	.....
October	47.3	..	NW	4945	47.2	.....	SE	5984	41.3	69.8	NW	7097	49.4	68.9	NW	6551	42.79	67.89	NW	5750	.....	.....	.....	.....
November	27.8	...	N	4450	23.8	.....	NW	5729	25.6	76.5	NW	6142	28.7	75.6	SE	7339	25.19	68.48	SE	6113	.....	.....	.....	.....
December	9.9	...	SW	4435	.....	.....	.....	.....	18.6	78.3	SW	5904	18.8	75.6	NW	6270	25.49	78.09	SE	6178	.....	.....	.....	.....
SANTA FÉ, N. MEX.																								
January	.....	...	.....	.....	27.0	.....	N	4104	29.0	.....	N	5181	31.0	60.5	N	5717	28.1	51.1	N	4724	29.0	46.8	NE	4878
February	.....	...	.....	.....	34.0	.....	N	4664	32.0	.....	SW	4773	27.8	62.0	NW	5083	31.4	48.4	N	5796	32.8	38.7	NW	5796.5
March	.....	...	.....	.....	38.8	.....	N	4640	44.0	.....	SW	5335	36.2	48.1	SW	5621	34.4	36.3	SW	7364	36.5	45.1	SW	7464.4
April	.....	...	.....	.....	45.8	.....	SW	6065	44.0	..	N	5816	42.1	35.8	E	5945	47.4	24.1	SW	6820	50.2	40.9	SW	6122.8
May	.....	..	.....	.....	58.1	.....	N	4730	56.0	.....	SW	5449	59.8	23.1	E	7391	59.2	25.3	SW	7405	55.9	42.1	SW	6818.5
June	.....	...	.....	.....	66 9	.....	SW	3855	65.6	.....	N	5050	69.3	19.5	SW	.....	67.9	19.8	SW	6933	66.0	46.7	SW	6569.8
July	.....	...	.....	.....	67.6	.....	NE	3607	71.0	.....	SE	5796	71.1	37.9	E	5286	65.2	54.9	SW	5437	69.2	64.6	E	5.81
August	.....	...	.....	.....	67.0	.....	S	3430	66.0	55.0	SW	5013	69.9	39.7	SW	5731	66.5	46.8	SW	5688	65.2	67.9	SW	4909
September	.....	...	.....	.....	60.0	.....	SE	3231	61.0	41.0	SW	4562	60.5	38.7	E	5163	58.7	56.1	SW	4879	.....	.....	.....	.....

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Statement showing mean monthly temperature and relative humidity, total monthly movement, and prevailing direction of wind, from January to October, 1877, inclusive, at the stations of observation of the United States Signal Service at Bismarck, Dak.; Breckenridge, Minn.; Cheyenne, Wyo.; Davenport, Iowa; Denver, Colo.; Dodge City, Kans.; Fort Gibson, Indian T.; Fort Sully, Dak.; Keokuk, Iowa; Leavenworth, Kans.; North Platte, Nebr.; Omaha, Nebr.; Saint Paul Minn.; Santa Fé, N. Mex.; and Yankton, Dak., compiled from the records on file in the office of the Chief Signal Officer of the Army.

Month.	Bismarck, Dak.				Breckenridge, Minn.				Cheyenne, Wyo.				Davenport, Iowa.				Denver, Colo.			
	Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.	
	Thermometer.	Relative humidity.	Prevailing direction.	Total movement.	Thermometer.	Relative humidity.	Prevailing direction.	Total movement.	Thermometer.	Relative humidity.	Prevailing direction.	Total movement.	Thermometer.	Relative humidity.	Prevailing direction.	Total movement.	Thermometer.	Relative humidity.	Prevailing direction.	Total movement.
1877.	°	*Per ct.*		*Mi'es.*	°	*Per ct.*		*Mi'es.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*
January	6.3	67.6	NW	4599	— 0.9	65.8	NW	8570	25	67.1	W	10052	17.2	77.7	SW	4262	24.1	62.8	S	4753
February	26.5	65.5	NW	3965	21.5	66.8	SE	7662	31.6	61	NW	7059	36.1	68.8	SW	4028	34.5	62.8	S	2997
March	19	78.4	NW	6261	15.2	76.5	NW	9131	35.9	59.5	W	10262	28.7	73.2	ENE	6858	42.8	46.3	S	5254
April	40.4	66.4	NE	6218	40.5	67.9	N	10080	38.2	65.3	W	9047	49.8	59.8	NE	7574	44.2	50.5	S	5228
May	56.9	71.7	S	5287	58.4	64.1	SE	10301	50.8	57.2	S	8199	62.2	58.5	E	7225	56.5	44	S	4521
June	59	66.5	NW	5631	58.9	70.3	NW	9205	59	42.6	S	8540	69.2	68.4	SW	6092	65.1	38.5	S	4212
July	70.9	63.6	S	6984	69.5	71.1	SE	9431	70.2	31.4	S	6621	75.3	64.6	SW	4782	73.8	31.9	S	4723
August	69.7	54.4	NW	6111	65.9	71.2	N	7790	67.9	36.8	S	6398	72.8	66.4	NW	3901	70.9	35.4	NW	4613
September	60.5	47.1	W	6473	58.5	69.9	S	8543	56.2	42.4	W	6654	67.3	65.9	SW	4365	61.9	36.2	SE	4689
October	42.3	64.4	W	5837	41.9	72.8	N	7793	40	61.1	W	7005	53.7	74.7	NW	5496	44.7	50.2	SE	4592

	Dodge City, Kans.				Fort Gibson, Ind. T.				Fort Sully, Dak.				Keokuk, Iowa.				Leavenworth, Kans.			
January	23.9	74.4	S	9891	33.7	67.2	S	5766	13.9	73.1	NW	5614	22.5	76.5	NW	5375	24.6	78.6	S	4976
February	37.1	73.6	N	7438	41.8	69.6	N	4035	33.4	71.4	NW	5649	38.4	71.9	N	5095	39.5	73.4	N	3884
March	42.6	57.1	N	11719	49.2	57.8	S	8493	23.8	82.9	NW	8742	32.6	79	N	7415	38.4	69.8	S	6804
April	50.1	61.9	N	12733	57.9	65.3	S	7162	44.7	67.1	NW	8666	51	72.2	NE	7515	53.3	64.9	N	6265
May	62.7	67.7	S	11998	68.2	65.7	SE	6961	58.6	75.3	SE	9765	62.3	70.8	SE	7238	63.8	69	S	5797
June	70.6	65.9	SE	9940	75.3	72.6	S	6248	63.6	61.7	NW	8734	71.7	71.2	SW	6368	71.9	70.1	S	5308
July	77.5	56.1	S	10007	78.2	68.3	S	4514	74.9	57.7	NW	a7111	76.7	69	NW	5078	76.3	67.9	S	4676
August	76.2	61.7	S	8127	77.1	67.1	SE	4118	72.7	52.8	SE	5741	74.4	69.9	N	4664	75.1	65.7	S	4089
September	68.4	55	S	9064	70.5	69.7	SE	4160	64.7	49.8	SE	3899	70.1	65.6	S	5101	67.9	67.2	S	3994
October	51.7	65.1	N	10078	60.5	71.5	S	6399	45	65.2	NW	2426	55.3	74.3	NW	6157	54.5	72.6	N	4458

	North Platte, Nebr.				Omaha, Nebr.				Saint Paul, Minn.				Santa Fé, N. Mex.				Yankton, Dak.			
January	17.4	80.5	W	8917	20.2	68.9	S	5488	10	71.8	SW	4614	31.7	47.1	NW	5092	13.6	69.5	NW	6741
February	34.1	70.6	W	*b*6748	37.3	67.6	N	4893	32	72.3	SE	4668	33.3	52.7	N	4738	36.4	67.4	NW	5812
March	32.7	73.7	W	10240	33.7	62.1	N	7722	23.7	71.1	NW	5922	*a*44.4	32	NW	5742	28.5	70.7	N	8372
April	45.4	60.4	E	*c*6235	50.5	56.7	N	8040	46.2	55.1	SE	7040	42.3	39.7	W	7498	45.8	67.7	NW	8922
May	57.9	64.9	SE	*d*9286	60.7	70.7	SE	6927	62	52.3	SE	6458	54.4	33	SW	6084	58.8	71.7	SE	8415
June	66.2	54.2	S	10712	69.1	68.2	N	6190	63.7	63.7	NW	6287	66.6	19.8	SW	6503	65	70.9	SE	7050
July	75.5	47.2	S	11145	76	62.4	S	6177	73.6	62.1	S	5986	68.6	44.8	SW	5860	73.4	68.4	SE	6958
August	72.8	57.5	NW	9591	*d*73.2	67.4	S	5241	72.2	72.2	NW	4363	68.4	37.4	E	4692	71.2	66.9	S	5836
September	64.6	52.9	NE	9510	66.6	69	S	5563	64	66.6	SE	5945	61.4	33.6	SE	5310	64.7	65.2	S	6203
October	44.6	64.8	NW	9228	51.1	73.6	N	5629	46.7	70.6	SW	5334	47.3	48.1	SW	5367	46.8	69.8	NW	6195

a 29 days. *b* 27 days. *c* Partial. *d* 30 days.

Station at Colorado Springs closed July 31, 1876.

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER, U. S. A.,
Washington, D. C., November 24, 1877.

Statement showing mean monthly temperature and relative humidity, prevailing direction of wind, and total monthly movement of wind at the stations of observation of the Signal Service United States Army, at Fort Benton, Mont.; Pembina, Dak.; Salt Lake City, Utah; Boise City, Idaho; and Yuma, Ariz.; for the periods given below. Compiled from the records on file in the office of the Chief Signal Officer United States Army.

Date.	Fort Benton, Mont.*				Pembina, Dak.†				Salt Lake City, Utah.‡				Boise City, Idaho.§				Yuma, Ariz.‖				
	Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly temperature.			Wind.	
	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	A. M., 5.05 (local time).	P. M., 2.05 (local time).	P. M., 8.30 (local time).	Prevailing direction.	Total movement.
1871.	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	°	°		*Miles.*
December	7.6	.....	SW	3133	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1872.																					
January	18.5	.....	SW	4363	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February	26	.....	SW	6614	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
March	36.7	.....	SW	5602	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
April	43.6	.....	SW	5925	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	55.1	.....	SW	6287	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	63.7	.....	SW	5627	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	61.4	.....	SW	4267	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
August	65.5	.....	SW	3997	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September	55.1	.....	SW	4022	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
October	47.2	.....	SW	3760	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November	24.3	.....	SW	4195	18.4	.....	NW	6089	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December	11.3	.....	SW	2527	No record.				.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1873.																					
January	16.5	.....	SW	5058	No record.				.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February	18.4	.....	SW	3050	No record.				.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
March	36.4	.....	SW	6139	12.9	.....	NW	9095	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
April	40.7	.....	SW	5059	33.9	.....	NW	7756	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	52.4	.....	E	5508	52.3	.....	SE	6328	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June	64.1	.....	SW	5687	66.1	.....	NW	6181	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	69.8	43.8	SW	5047	65.2	67.5	NW	5843	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
August	69.3	44.9	SW	4676	64.4	73.6	SE	6151	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September	53.2	50.6	W	5840	46.8	76.4	NW	6228	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
October	40.3	51.7	SW	5639	35.4	75	NW	8089	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

November	35.1	57.7	SW	6348	16.1	87.7	NW	6708															
December	13.7	73.9	W	4271	6.6	86.5	SE	6608															
1874.																							
January	11.3	73.2	N	6053	— 3	84.5	NW	7418															
February	22.4	59	SW	5574	2.6	80.7	SE	7014															
March	18.4	83.4	N	4700	11.9	80.5	NW	8613	33.1	73.1	N	3565											
April	44.4	58.7	SW	5997	29.4	78.8	NW	7449	48.2	40	NW	4227											
May	59.2	52.1	E	6737	55.3	62.9	NW	7376	61.6	40	NE	4116											
June	63	53.9	SW	5569	64.4	70.5	SE	6075	68.1	33	NE	4231											
July	75.1	30.5	W	6378	69.9	65.5	NW	7144	78.2	41.8	NW	3421											
August	69.1	45.2	SW	6355	67	72.9	SE	4706	74.7	32.5	SE	3924											
September	58.2	41.8	SW	4837	56.2	74.8	NW	7124	62.6	28.8	NW	3240											
October	49.8	53.8	SW	4317	42.2	70.3	NW	7978	55.6	46.5	NW	2681											
November	19.4	72.7	SW	5992	14.4	81.6	NW	7598	44.4	52.6	NW	3076											
December	29.6	66.7	SW	7742		No record.			33	58.5	SE	2272											
1875.																							
January	— 8.6	96.1	SW	5228		No record.			29.4	61.8	NW	3395											
February	13.9	89.8	SW	4453		No record.			33.7	52.9	NW	2701											
March	27.8	70.3	SW	8264		No record.			35.2	50	N	4492											
April	43	60.5	SW	6799	32.9	75.5	NE	8065	50.3	41.3	N	4394											
May	58.1	41.6	W	7887	53.3	61.1	SE	7415	60.1	37.5	NE	4672											
June	62	55.2	W	7433	59.2	59.3	SE	Nor'd	69.1	78.9	NE	4407											
July	74.5	47.4	W	4988	64.9	68.9	NW	5369	74.7	30	N	3923											
August	68.9	43.3	W	5001	64.3	72.1	SE	5308	76.2	23.1	N	4406											
September	60.6	41.6	W	4427	52.7	73.1	NW	5093	68.8	31.1	NE	3356											
October	51.1	55.9	SW	4537	37.5	78.2	NW	6797	59.3	34.6	NW	3087								66.2	87.7	76.5	E
November	17.1	73.8	SW	5698	11.1	91.6	NW	6697	44	60.4	N	3262								54.1	73.8	61.1	W
December	36.8	60.8	SW	8459	8.1	93.5	NW	8014	35.5	70	SW	2031								46.5	69.3	56.2	NW
1876.																							
January	13.9	81.9	SW	6171	— 2.6	92.4	NW	6987	30.4	67.9	S	2915								42.1	60	50.6	NW
February	16.7	84	NE	5005	— 4.5	91.9	NW	6920	35.5	59.5	N	2460								50.2	69.5	58.8	NW
March	13.3	82.8	SW	3216	6.5	86.6	NW	7725	37.9	50.9	N	4169								51.6	71.5	62.6	W
April	47.4	51.6	SW	6127	35.4	71.1	NW	6471	50.3	40.4	N	3689								60	85.2	72.9	W
May	56.8	55.2	SE	7151	54.6	61.7	NW	6737	56.9	47.7	NW	3557								72.7	92.5	80.6	SW
June	63.8	54.7	W	5856	60.5	68.4	NW	5703	69.9	32.7	NE	3570								77.7	102	88.2	SW
July	68.6	50.4	W	5203	67.4	70.8	NW	5346	76.9	30.2	NW	4452								84.5	103.1	94.1	S
August					63.7	76.9	SE	5494	72.6	29.3	SE	4910								82.1	99	89.9	S
September					51.9	74.8	NW	4992	65.6	29.8	NW	4521								76	96.8	86.2	S
October					37.1	71.6	NW	7131	54.6	47.3	NW	3418								67.1	87.6	76.3	S
November					15.4	81.8	NW	5976	40.5	53.6	NW	2887								56.4	75.9	63.9	N
December					— 6.3	74	S	6510	26.6	89.2	NW	1636								49.6	70.6	57.6	N

* Station discontinued July 31, 1876.
† Station opened October 15, 1872.
‡ Station opened March 19, 1874.
§ Station opened July 1, 1877.
‖ No meteorological reports received prior to October, 1875.
No local observations 7 a. m., 2 and 9 p. m., were taken at Yuma.

Statement showing the monthly temperature and relative humidity, prevailing direction of wind, &c.—Continued.

Date.	Fort Benton, Mont.				Pembina, Dak.				Salt Lake City, Utah.				Boise City, Idaho.				Yuma, Ariz.				
	Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly.		Wind.		Mean monthly temperature.			Wind.	
	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	Temperature.	Relative humidity.	Prevailing direction.	Total movement.	A. M., 5.05 (local time).	P. M., 2.05 (local time).	P. M., 8.30 (local time).	Prevailing direction.	Total movement.
1877.	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	*Per ct.*		*Miles.*	°	°	°		*Miles.*
January	.....	.....	.....	.....	— 5.2	75.3	S	6531	27.9	74.9	SE	3222	.....	.....	.....	.....	51.7	69	60.1	N	.....
February	.....	.....	.....	.....	17.4	83	S	6555	33.7	75.3	NW	2411	.....	.....	.....	.....	56.5	74.4	64.1	W	.....
March	.....	.....	.....	.....	8.3	80.6	NW	7243	48	52.9	NW	4219	.....	.....	.....	.....	61.1	82.3	72	W	.....
April	.....	.....	.....	.....	33.1	73.9	NW	6297	48.6	43	NW	5206	.....	.....	.....	.....	56.7	79.1	69.4	W	.....
May	.....	.....	.....	.....	56.8	65.7	SE	7147	56.7	42.1	NW	6291	.....	.....	.....	.....	Thermometer broken.				
June	.....	.....	.....	.....	55.7	67.7	NW	5861	65.9	29.7	NW	4531	.....	.....	.....	.....	Thermometer broken.				
July	.....	.....	.....	.....	68.1	69.3	S	6829	78.2	24.1	NW	5165	74.9	36.8	NE	3274	82	105.1	95	SE	4040
August	.....	.....	.....	.....	64.3	68.9	NW	6219	76.3	25.1	NW	3848	73.9	33.3	NE	2367	78.7	105.4	93.9	W	3730
September	.....	.....	.....	.....	55.4	68.1	S	6737	65	31.5	NW	1534	61	48	S	2599	68.3	98.5	83	S	3583
October	.....	.....	.....	.....	40	71.4	NW	6227	51	41	NW	3998	49	57.1	S	1942	.....	.....	.....	.....	.....

WAR DEPARTMENT, OFFICE OF THE CHIEF SIGNAL OFFICER U. S. A.,
Washington, D. C., November 24, 1877.

Synopsis of the monthly mean temperature and prevailing winds in the locust area, 1872–1877, from the preceding data, as furnished by the Chief Signal Officer United States Army.

May.

Station.	1872.		1873.		1874.		1875.		1876.		1877.	
	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.
Davenport, Iowa	61.5	NW	59.6	NE	64.5	SW	60.9	E	62.4	SW	62.2	E
Bismarck, Dak	.....	.....	.....	.....	.....	.....	56.1	S	56	SE	56.9	S
Breckenridge, Minn	53	SE	52	SE	60.2	SE	56	SE	56.3	SE	58.4	SE
Cheyenne, Wyo	52	N	49.2	W	56.6	W	54.7	W	50.6	W	50.8	S
Denver, Colo	57.7	N	55.3	NE	61.9	S	60.2	S	57.1	N	56.5	S
Dodge City, Kans	.....	.....	.....	.....	.....	.....	65.4	N	64.5	E	62.7	S
Fort Gibson, Ind. T	.....	.....	67.6	E	70.3	E	67.6	SE	69.6	SE	68.2	SE
Fort Sully, Dak	58.3	NW	54.5	E	63.2	SE	60.1	NW	61.7	SE	58.6	SE
Keokuk, Iowa	64.5	W	61.5	E	67.2	S	62.9	SE	63.9	S	62.3	SE
Leavenworth, Kans	65.6	SW	63	S	67.3	S	65.8	S	65.5	S	63.8	S
North Platte, Nebr	.....	.....	.....	.....	.....	.....	61.3	SE	59.6	SE	57.9	SE
Omaha, Nebr	61	SSE	59	N	66.6	S	64.2	SE	63.6	S	60.7	SE
Saint Paul, Minn	55.2	W	55.1	N	62.2	N	58.8	SE	59.2	SE	62	SE
Santa Fé, N. Mex	58.1	N	56	SW	59.8	E	59.2	SW	55.9	SW	54.4	SW
Yankton, Dak	.....	.....	54.2	NE	62.1	S	60.2	NW	61.6	SE	58.8	SE
Fort Benton, Mont	55.1	SW	52.4	E	59.2	E	58.1	W	56.8	SE	....	.....
Pembina, Dak	.....	.....	52.4	SE	55.3	NW	53.3	SE	54.6	NW	56.8	SE
Salt Lake City	.....	.....	.....	.....	61.6	NE	60.1	NE	56.9	NW	56.7	NW
Boise City	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Yuma, Ariz	.....	.....	.....	.....	.....	.....	.....	.....	72.7	SW	.....	.....
Colorado Springs	.....	.....	.....	.....	58.6	N	57.3	S	54.9	SE	.....	.....

June.

Station.	1872.		1873.		1874.		1875.		1876.		1877.	
	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.
Davenport, Iowa	73.2	SW	77.9	SW	73.2	SW	68.6	NW	69.4	SW	69.2	SW
Bismarck, Dak	.....	.....	.....	.....	.....	.....	61.4	W	60.9	E	59	NW
Breckenridge, Minn	65	SE	69.5	SE	65.9	SE	69.8	SE	63.1	NW	58.9	NW
Cheyenne, Wyo	51.5	W	69.5	W	65.2	W	63.7	W	60.8	W	59	S
Denver, Colo	67.3	S	68.9	S	70	S	70.4	S	65.9	S	65 1	S
Dodge City, Kans	.....	.....	.....	.....	.....	.....	75.4	S	71.2	SE	70.6	SE
Fort Gibson, Ind. T	.....	.....	70.6	SE	78.6	SE	77.9	S	73.6	W	75.3	S
Fort Sully, Dak	70.3	SE	74.2	SE	70.2	SE	66	SE	68.1	NW	63.6	NW
Keokuk, Iowa	75.2	S	77.9	SE	76.9	SW	71.4	SE	70.1	NW	71.7	SW
Leavenworth, Kans	77.2	SW	75.5	S	77.4	S	76.7	S	71.2	S	71.9	S
North Platte, Nebr	.....	.....	.....	.....	.....	.....	69.9	SE	67.9	N	66.2	S
Omaha, Nebr	72.7	SSE	74.4	S	73.2	S	71.1	S	68.6	N	69.1	N
Saint Paul, Minn	67.9	SE	73	SE	68.7	SE	63.6	SE	66.3	NW	63.7	NW
Santa Fé, N. Mex	66.9	SW	65.6	N	69.3	SW	67.9	SW	66	SW	66.6	SW
Yankton, Dak	.....	.....	72.6	S	70.7	SE	66.1	SE	65.7	NW	65	SE
Fort Benton, Mont	63.7	SW	64.1	SW	63	SW	62	W	63.8	W	.....	.....
Pembina, Dak	.....	.....	66.1	NW	64.4	SE	59.2	SE	60.5	NW	55.7	NW
Salt Lake City	.....	.....	.....	.....	68.1	NE	69.1	NE	69.9	NE	65.9	NW
Boise City	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Yuma, Ariz	.....	.....	.....	.....	.....	.....	.....	.....	77.7	SW	.....	.....
Colorado Springs	.....	.....	.....	.....	68.9	S	67.9	S	64	N	.....	.....

Synopsis of the monthly mean temperature and winds in the locust area, &c.—Continued.

July.

Station.	1872.		1873.		1874.		1875.		1876.		1877.	
	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.
Davenport, Iowa	76.3	NW	75.6	SW	78	SW	74	E	75.9	SW	75.3	SW
Bismarck, Dak	.....	.....	.....	.....	.....	.....	69.3	NE	70.3	NW	70.9	S
Breckenridge, Minn	67.1	SE	67.6	SE	70.2	S	67.7	N	70.9	SE	69.5	SE
Cheyenne, Wyo	64.5	W	69.7	W	71.8	S	64	S	72.3	S	70.2	S
Denver, Colo	69.3	S	71.5	S	76.1	S	68.1	S	76.4	S	73.8	S
Dodge City, Kans	.....	.....	.....	.....	.....	.....	75.5	NE	79.6	SE	77.5	S
Fort Gibson, Ind. T	.....	.....	80.7	SE	83.1	SE	80	S	81	E	78.2	S
Fort Sully, Dak	73.5	SE	74.3	SE	79.2	SE	73.9	SE	75.6	SE	74.9	NW
Keokuk, Iowa	78.6	NW	76.3	SE	80.5	SW	76.3	SW	76.5	E	76.7	NW
Leavenworth, Kans	78.4	SE	77.5	S	82.8	S	77.6	S	78.9	S	76.3	S
North Platte, Nebr	.....	.....	.....	.....	.....	.....	72.5	NE	76.3	SE	75.5	S
Omaha, Nebr	77	SE	75.7	S	80	SSW	74.4	SE	75.1	S	76	S
Saint Paul, Minn	71.2	S	71	SE	74.7	SE	73.8	NW	....	.....	73.6	S
Santa Fé, N. Mex	67.6	NE	71	SE	71.1	E	65.2	SW	69.2	E	68.6	SW
Yankton, Dak	.....	.....	74.7	S	78.2	SW	71.8	SE	73.3	S	73.4	SE
Fort Benton, Mont	61.4	SW	69.8	SW	75.1	W	74.5	W	68.6	W	.....	.....
Pembina, Dak	.....	.....	65.2	NW	69.9	NW	64.9	SW	67.4	NW	68.1	S
Salt Lake City	.....	.....	.....	.....	78.2	NW	74.7	N	76.9	NW	78.2	NW
Boise City	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	74.9	NE
Yuma, Ariz	.....	.....	.....	.....	.....	.....	.....	.....	84.5	S	82	SE
Colorado Springs	.....	.....	.....	.....	73.2	NW	64.6	SE	72	N	.....	.....

August.

Station.	1872.		1873.		1874.		1875.		1876.		1877.	
	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.
Davenport, Iowa	74.6	SW	78	SW	74.4	E	69.9	S	74.9	SE	72.8	NW
Bismarck, Dak	.....	.....	.....	.....	.....	.....	66.2	NW	68	NW	69.7	NW
Breckenridge, Minn	65.1	SE	67	SE	67.8	SE	63.8	SE	67.7	SE	65.9	N
Cheyenne, Wyo	65.1	W	43.1	W	68.6	W	63.2	NW	66.5	NW	67.9	S
Denver, Colo	69.8	S	70.9	S	73	S	69	S	70.1	S	70.9	NW
Dodge City, Kans	.....	.....	.....	.....	.....	.....	74.6	S	77.2	S	76.2	S
Fort Gibson, Ind. T	.....	.....	78.8	E	86.1	E	74.6	SE	81.4	SE	77.1	SE
Fort Sully, Dak	72.2	SE	75.5	ESE	76.1	SE	71.4	N	73.1	SE	72.7	SE
Keokuk, Iowa	77.3	S	78.7	SW	76.8	E	71.6	S	76.2	S	74.4	N
Leavenworth, Kans	78.4	SE	79.2	S	81.3	S	73.1	S	78.2	S	75.1	S
North Platte, Nebr	.....	.....	.....	.....	.....	.....	71.7	SE	72.8	SE	72.8	NW
Omaha, Nebr	75.6	SSE	77.1	S	77.3	S	70.2	S	75.4	S	73.2	S
Saint Paul, Minn	69.2	S	70.7	SE	70.5	SE	66.6	SE	69.9	SE	72.2	NW
Santa Fé, N. Mex	67	S	66	SW	69.9	SW	66.5	SW	65.2	SW	68.4	E
Yankton, Dak	.....	.....	77.1	E	74.2	SE	68.3	SE	72.1	SE	71.2	S
Fort Benton, Mont	65.5	SW	69.3	SW	69.1	SW	68.9	W	.....	.....	.....	.....
Pembina, Dak	.....	.....	64.4	SE	67	SE	64.3	SE	63.7	SE	64.3	NW
Salt Lake City	.....	.....	.....	....	74.7	SE	76.2	N	72.6	SE	76.3	NW
Boise City	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	73.9	NE
Yuma, Ariz	.....	.....	.....	.....	.....	.....	.....	.....	82.1	S	78.7	W
Colorado Springs	.....	.....	.....	.....	70.3	NW	65.3	N	....	.....	.....	.....

Synopsis of the monthly mean temperature and winds in the locust area, &c.—Continued.

Station.	September.											
	1872.		1873.		1874.		1875.		1876.		1877.	
	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.	Mean temperature.	Wind.
Davenport, Iowa	64.6	SW	62.3	SW	65.5	SW	61.7	SW	.....	.....	67.3	SW
Bismarck, Dak	.....	.....	.....	.....	.....	.....	55.1	NW	.....	.....	60.5	W
Breckenridge, Minn	58.3	SE	49.1	NW	57.7	S	55.4	NW	.....	.....	58.5	S
Cheyenne, Wyo	55.6	NW	55.9	.....	54.2	W	56	NW	.....	.....	56.2	W
Denver, Colo	60.1	S	59.8	S	59	S	61.7	S	.....	.....	61.9	SE
Dodge City, Kans	.....	.....	.....	.....	.....	.....	68.7	S	.....	.....	68.4	S
Fort Gibson, Ind. T	....	....	70.2	SE	71.5	SE	.....	.....	.....	.....	70.5	SE
Fort Sully, Dak	62.4	NW	57.3	NW	65.2	SE	61.3	N	.....	.....	64.7	SE
Keokuk, Iowa	67.7	SW	65.4	S	66.8	S	66.6	S	.....	.....	70.1	S
Leavenworth, Kans	62.2	S	63.9	NW	67.1	S	64.3	S	.....	.....	67.9	S
North Platte, Nebr	.....	.....	.....	.....	.....	.....	63.5	SE	.....	.....	64.6	NE
Omaha, Nebr	62.8	SE	60.6	S	63	S	62.9	S	.....	.....	66.6	S
Saint Paul, Minn	57.6	.....	54.1	NW	60.9	SE	57.2	SE	.....	.....	64	SE
Santa Fé, N. Mex	60	SE	61	SW	60.5	E	58.7	SW	.....	.....	61.4	SE
Yankton, Dak	....	.....	60	NW	61.7	NW	60.6	NW	.....	.....	64.7	S
Fort Benton, Mont	55.1	SW	53.2	W	58.2	SW	60.6	W	.....	.....	.....	.....
Pembina, Dak	....	.....	46.8	NW	56.2	NW	52.7	NW	51.9	NW	55.4	S
Salt Lake City	.....	.....	.....	.....	62.6	NW	68.8	NE	65.6	NW	65	NW
Boise City	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	61	S
Yuma, Ariz	.....	.....	.....	.....	.....	.....	.....	.....	76	S	68.3	S
Colorado Springs	.....	.....	.....	.....	56.7	SE	57.9	N	.....	.....	.....	.....

The following thoughts on the subject are taken, with some omissions and alterations, from Mr. Packard's Report to Dr. Hayden.[26]

We have shown that the exceptional years when the locust migrates are periods of unusual heat and dryness, conditions unusually favorable to the excessive increase of insect life, as is the case with the Eastern and California locust, the grass army-worm, the grain-aphis, and the chinch-bug. When the early part of the season, the spring and early weeks of summer, are warm and dry, without sudden changes of temperature, insects abound, and enormously exceed their ordinary numbers. When two such seasons occur, one after the other, the conditions become still more favorable for the undue development of insect life. It is well known that in the Eastern States the summers of 1860 and 1874 preceding the appearance of the army-worm and grain-aphis, were unusually warm and dry, and favorable not only for the hatching of the eggs laid the year previous, but for the growth and development of the larvæ or young. Look now at the conditions for the development of locust life on the hot and dry plains—Montana, Wyoming, and Utah. We have no extended meteorological records from these regions at hand, but from the data we have given it is more than probable that the years preceding the migrations of the locusts were exceptionally warm and dry, when the soil was parched with long-sustained droughts, as we

[26] Report on the Rocky Mountain Locust and other Insects, etc. 9th Ann. Rep. U. S. Geol. Surv. Ter. for 1876, 1877, pp. 640–647.

know that the corresponding species east of the Mississippi River abounds during dry summers following dry and warm springs.

Given, then, the exceptional years of drought and heat and the great extent of territory, and we have as the result vast numbers of young hatched out. The year previous having perhaps been warm and dry, the locusts would abound, and more eggs than usual would be laid. These would, with remarkably few exceptions, hatch, and the young soon consume the buffalo grass and other herbage, and move about from one region to another, following often a determinate course, in search of food. In about six or seven weeks they acquire wings. Experience shows that the Western locust as soon as it is fledged rises up high in the air, sometimes a thousand feet or much higher. They have been seen to settle at night on the ground, eat during this time, and toward noon of the next day fill the air again with their glistening wings. As more and more become fledged, the vast swarm exhausts the supply of food, and when the hosts are finally marshalled, new swarms joining perhaps the original one, the whole swarm, possibly hundreds of square miles in extent, begins to fly off, borne by favorable westerly and northwesterly winds, in a generally easterly and southeasterly course.

Though the winds may vary and counter-currents exist, and storm-gusts from due north, such as often sweep over the plains, and local southerly breezes may retard their flight, the course of the swarms east of the Rocky Mountains is either eastward or southeasterly. The relations between the average direction of the winds and the migrations of the locusts have, however, never been sufficiently studied, either, so far as we are aware, in Europe or in this country. And yet, if we would intelligently study the causes of the excessive increase and migrations of the locust, we must examine the meteorological features of the country, ascertain the periods of drought and undue rain-fall, the average direction of the wind for the different months, in order to learn how far they correspond with the phenomena of insect-life. That there are meteorological cycles, dry and hot seasons recurring at irregular intervals, while the general average may remain nearly the same century after century, is supported, though it may be vaguely, by observed meteorological facts.

The question then arises, *Can meteorologists predict the coming of seasons of undue heat and drought, and consequently can we predict locust years?* It is probable that we shall, after the lapse of years, be able to foretell with a good degree of certainty locust invasions, and be able to provide against the losses thus incurred.

The return migration.—By simultaneous observations for a number of years over the region liable to be visited by migratory hordes of locusts, added to the knowledge we already possess, it will not only be possible to predict the course of certain swarms from their breeding places, and their probable destination—so that when swarms start from Montana or Wyoming their arrival in Colorado may with some certainty be pre-

dicted; and, again, their arrival in the States east of the great plains be announced with a certain degree of precision, as indeed could now in some measure be done from the experience we have already had—but we may be able to foretell the course taken in the return flight of their progeny in the early part of the succeeding season. It remains to determine the causes of this return migration, this completion of the "migration cycle," as Mr. Dawson terms it. It is evident that in this case the desire for food is not the cause, for food is many times more abundant in the Mississippi Valley than on the plains whither they return. The solution of the problem, we think, must be sought in the direction of the prevailing winds during the spring months up to the middle of June—the time when they become winged.

South of latitude 40° the locusts fly before the first of July from the southeast. In Texas, Missouri, and Kansas, and probably Nebraska, this is the universal experience, and south of latitude 40° the winds in the spring are universally southerly; on the other hand, later in the season, the prevailing winds are northerly or northwesterly.

North of the fortieth parallel, in Iowa and Minnesota especially, the locusts do not return as a body to the northwest, though many do, and careful observations by experts are needed to determine the relation between the prevailing direction of the winds and the variable and uncertain course assumed by the native-born broods of the Rocky Mountains. Granting, therefore, this setting-in of southerly and easterly winds, which may last until the locusts are winged, when they rise on the wing into the air they are known to move in a general northwest direction. It is known from the observations made during the past season that they are borne along by these southeasterly winds, and pass over on to the plains from Texas to Colorado, Wyoming, and Nebraska, as is stated in chapter VIII, to which the reader is referred for a discussion of the immediate or more special causes of migration. The cause is seen, then, to be entirely independent of the question of subsistence; possibly the reproductive instinct; as well as the adverse features of a damp, hot, debilitating climate, like that of Texas and the border States, as compared with the native breeding places of their parents, which cause them to become uneasy, restless, to assemble high in the air, and seek the dry, hot, elevated plateau of the northwest. Should this be so, the cause of their migrations is probably purely mechanical. We may expect in the future as in the past that south of latitude 40° the spring and early summer migrations from the eastern limits of the locust area will be always toward the northwest, and that the July, August, and early September migrations from the Rocky Mountain plateau will be in a general easterly and southeasterly direction.

The following remarks on the connection between meteorological phenomena and locust migrations have been communicated by Mr. Cleveland Abbe, who writes as follows:

It is impossible for me to satisfactorily investigate the question of locust migrations as affected by the weather without going into a very extensive review of the whole of

the locust-life, which is itself directly or indirectly influenced by the weather at every stage, from the deposition of the egg through the life of the young and the mature insect, up to the period of its migration and final deposition of new eggs in a new locality.

From the data given in the preceding part of this chapter it has been made probable that locust visitations are coincident with years of little rain, but it still remains an open question whether the weather has directly affected the insect or only indirectly through its influence upon the crops and the parasites. It is difficult to separate these two modes of action without going into minute details as to the relations between the daily life of the insect and the weather actually prevailing; all generalities as to monthly or annual means of temperature, rain-fall, winds, &c., or as to the sun-spot period, as affecting the growth and migration of the locust, are very likely to contain errors due to our own want of a correct guiding theory, based on a knowledge of the peculiarities of the locust.

It would be perfectly practicable to prepare a series of daily maps showing the weather, winds, &c., of each afternoon over the locust areas, and on these maps also graphically present daily systematic reports of locust-life, migrations, &c. This is the most thorough method of searching for the general laws that we are now desirous to find. A series of such maps and reports would, in one season, show most positively what atmospheric features directly, and what indirectly, affect the locust. In the absence of such minute study, I offer the following result:

I note the following three epochs of locust migration, *i. e.:*

1. A slow change of locality during the hottest portion of the day, evidently dictated entirely by the scarcity and search for food; this occurs while unfledged (before the fourth molt—Riley's Report, 1876, p. 100), and is especially active during May and a part of April.

2. Later in their life occurs the grand migratory movement of large bodies in a uniform direction, and to considerable distances. This is repeated daily from 9 a. m. to sunset, if the weather is favorable, and is followed by deposition of eggs in the new country and the death of the female. This migration takes place within two weeks after the fourth molt, and continues through June and July.

3. The broods hatched out in foreign or low lands apparently attempt, when their migration begins, to return to the original breeding-grounds near the Rocky Mountains.

In general, the most important climatic element affecting migration is believed to be the wind. It will, however, not do to confine ourselves to the "prevailing wind," by which is technically meant that one which has occurred most frequently during the month, nor to the mean movement, nor to the resultant movement of the wind, but we must study the relative frequency of the winds from each point of the compass and their individual characteristics as to relative humidity, temperature, velocity, rain-fall, &c.

I have, therefore, compiled the following tables of wind-frequency for May to September and for 1874, '75, and '76, from the summaries published in the annual reports of the Chief Signal Officer for 1873 to 1877, inclusive.

In future investigations the tables may be enlarged by addition of the numerous stations now maintained in Texas, for which the wind-frequency is not given in the annual reports referred to, for the years 1874, '75, '76.

Table of wind frequency, or number of times each wind was observed at the hours of 7 a. m., 2 p. m., and 9 p. m., compiled from the annual reports of the Chief Signal Officer, 1873, 1874, 1875, 1876, and 1877.

Station.	Date.	N.	N.W.	W.	S.W.	S.	S. E.	E.	N. E.	Calm.
(1) Bismarck, Dak	May, 1874	5	22	4	11	4	23	5	18	1
	5	16	17	10	4	21	6	9	9	1
	6	17	15	3	2	8	23	11	14	0
	June, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	11	21	4	3	13	6	23	9	0
	6	18	28	5	5	6	8	6	10	4
	July, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	14	14	8	9	11	10	6	21	0
	6	10	19	1	7	19	13	10	5	2
	Aug., 1874	3	15	25	14	7	9	10	10	0
	5	16	21	6	4	15	10	6	14	1
	6	10	18	2	2	17	11	6	9	18
	Sept., 1874	11	5	12	8	5	10	20	13	6
	5	21	22	4	6	10	5	9	11	2
	6	12	14	1	0	2	10	4	17	30
(2) Breckenridge, Minn	May, 1874	22	13	0	3	8	27	9	9	2
	5	18	12	6	3	15	24	4	9	2
	6	14	9	8	4	6	24	16	12	0
	June, 1874	11	8	5	5	19	24	6	9	3
	5	14	11	5	3	20	28	0	5	4
	6	15	19	17	5	5	17	5	6	1
	July, 1874	22	9	1	4	26	14	1	4	12
	5	22	12	2	9	13	12	2	12	9
	6	14	8	6	3	9	30	12	9	2
	Aug., 1874	11	6	3	7	18	19	2	7	20
	5	23	13	1	7	8	30	1	6	4
	6	9	10	10	6	5	37	12	3	1
	Sept., 1874	7	16	8	5	30	19	0	3	2
	5	12	20	1	7	11	19	1	9	10
	6	13	27	7	4	1	18	14	3	3
(3) Cheyenne, Wyo	May, 1874	9	11	18	4	13	12	9	7	10
	5	8	24	21	7	15	7	5	5	1
	6	13	17	15	10	14	4	5	4	1
	June, 1874	11	15	16	6	17	7	10	1	7
	5	9	16	27	6	18	6	3	4	1
	6	17	16	18	11	10	8	5	5	0
	July, 1874	10	10	17	2	25	6	5	6	12
	5	15	21	10	6	18	11	6	4	2
	6	6	16	13	15	25	6	5	7	0
	Aug., 1874	9	11	30	13	18	4	5	0	3
	5	11	23	12	13	17	10	0	7	0
	6	11	11	18	17	15	8	8	5	0
	Sept., 1874	14	13	26	11	16	6	1	2	1
	5	11	27	6	9	14	11	6	3	3
	6	18	21	10	10	7	13	0	8	3
(4) Colorado Springs, Colo	May, 1874	15	6	5	5	14	9	4	5	30
	5	27	11	8	8	19	15	1	2	2
	6	20	13	8	8	3	26	5	5	5
	June, 1874	6	9	6	4	34	13	1	4	13
	5	24	13	9	3	11	18	4	4	4
	6	22	11	0	3	9	21	4	17	3
	July, 1874	0	34	7	7	19	12	5	5	4
	5	22	14	3	5	9	29	2	3	6
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Aug., 1874	0	35	5	18	31	0	0	0	4
	5	27	18	6	2	10	15	3	5	7
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Sept., 1874	31	13	3	2	4	31	0	1	3
	5	39	9	1	4	8	20	2	2	5
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
(5) Davenport, Iowa	May, 1874	14	11	5	22	14	9	13	4	1
	5	6	12	8	10	12	14	15	3	13
	6	4	9	3	24	7	7	14	10	15
	June, 1874	3	8	18	19	10	9	17	1	5
	5	6	13	4	13	8	8	20	14	4
	6	4	13	13	20	16	2	6	10	6
	July, 1874	7	12	11	24	12	8	8	7	4
	5	8	4	8	17	6	7	15	10	18
	6	5	7	5	19	13	7	17	13	7
	Aug., 1874	9	5	3	18	6	7	33	10	2
	5	8	11	8	11	18	6	5	7	19
	6	9	8	4	9	16	22	13	6	6
	Sept., 1874	7	9	12	22	9	11	8	9	3
	5	7	14	9	23	10	4	14	8	1
	6	9	17	6	8	4	9	19	9	9

Table of wind frequency, or number of times each wind was observed, &c.—Continued.

Station.	Date.	N.	N.W.	W.	S.W.	S.	S. E.	E.	N. E.	Calm.
(6) Denver, Colo	May, 1874	11	16	5	8	18	19	4	12	0
	5	10	11	6	4	25	8	8	7	14
	6	19	9	2	4	24	8	4	10	13
	June, 1874	6	7	3	6	19	20	9	18	2
	5	12	8	2	5	23	11	9	13	7
	6	16	10	4	4	21	5	9	13	8
	July, 1874	16	7	4	7	29	12	4	14	0
	5	10	14	6	8	25	9	7	12	2
	6	8	8	7	3	39	11	6	2	9
	Aug., 1874	12	8	5	4	37	8	9	9	1
	5	24	9	3	1	22	11	8	14	1
	6	15	7	9	4	35	4	4	5	10
	Sept., 1874	13	2	3	4	30	12	10	15	1
	5	14	14	3	4	20	14	6	13	2
	6	11	8	7	5	24	3	4	19	9
(7) Dodge City, Kans	May, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	24	8	5	9	21	13	4	9	0
	6	15	10	5	2	9	18	22	11	1
	June, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	12	2	7	9	43	6	1	10	0
	6	13	14	11	6	6	22	14	4	0
	July, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	17	0	2	12	19	9	7	27	0
	6	5	0	5	2	18	26	32	4	1
	Aug., 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	1	0	1	1	38	23	14	15	0
	6	9	3	3	1	33	24	16	4	0
	Sept., 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	19	4	0	8	39	1	7	12	0
	6	13	7	0	3	19	17	12	15	4
(8) Dubuque, Iowa	May, 1874	4	13	2	3	11	13	5	7	35
	5	7	13	9	9	10	28	4	6	7
	6	4	12	3	22	10	14	11	10	7
	June, 1874	1	6	7	11	12	6	5	5	37
	5	4	14	12	5	5	21	14	7	8
	6	4	14	15	22	13	9	4	6	3
	July, 1874	4	7	7	8	14	6	5	4	38
	5	8	10	10	9	10	7	13	9	17
	6	4	11	6	8	21	9	10	10	14
	Aug., 1874	10	9	3	4	9	9	9	12	28
	5	9	15	13	9	14	10	5	2	16
	6	2	13	6	6	18	30	2	5	11
	Sept., 1874	3	12	5	7	18	9	6	0	30
	5	7	17	10	6	17	7	8	6	12
	6	6	25	2	2	11	9	11	11	13
(9) Fort Benton, Mont	May, 1874	14	6	13	15	4	4	22	5	10
	5	5	8	23	28	8	2	9	2	8
	6	12	14	9	18	6	15	6	3	10
	June, 1874	9	3	17	21	17	0	9	6	8
	5	12	7	21	13	3	8	11	4	11
	6	6	8	13	23	2	7	14	5	12
	July, 1874	9	2	20	11	9	2	12	7	12
	5	7	5	17	15	4	4	14	9	18
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Aug., 1874	10	1	17	20	5	3	21	6	10
	5	10	6	16	18	2	4	11	12	14
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Sept., 1874	8	8	4	32	6	1	5	2	24
	5	9	8	11	13	5	0	12	7	25
	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
(10) Fort Gibson, Ind. T	May, 1874	11	1	6	5	20	24	14	1	11
	5	11	4	1	9	19	30	16	1	2
	6	5	9	4	2	19	39	13	0	2
	June, 1874	5	2	3	6	27	28	11	3	5
	5	7	7	0	7	32	31	3	0	3
	6	4	4	18	14	16	15	10	3	6
	July, 1874	7	2	3	6	23	28	12	5	7
	5	7	2	6	12	23	29	8	0	6
	6	0	4	5	6	15	23	33	6	1
	Aug., 1874	6	1	2	13	20	17	25	3	6
	5	12	12	2	4	8	32	10	3	10
	6	1	1	2	1	6	34	30	17	1
	Sept., 1874	11	7	2	4	11	24	19	2	10
	5	11	6	4	3	7	10	15	2	9
	6	9	7	12	4	6	21	23	6	2

Table of wind frequency, or number of times each wind was observed, &c.—Continued.

Station.	Date.	N.	N.W.	W.	S.W.	S.	S. E.	E.	N. E.	Calm.
(11) Fort Sully, Dak	May, 1874	18	10	7	1	8	24	10	7	2
	5	12	15	4	0	9	19	8	4	22
	6	10	23	5	1	18	24	3	6	3
	June, 1874	14	16	10	5	10	22	4	5	4
	5	19	9	3	2	2	25	19	4	7
	6	20	35	3	0	8	18	0	2	4
	July, 1874	19	13	3	4	10	28	11	3	2
	5	9	10	15	0	7	26	13	2	11
	6	14	13	4	2	21	35	1	1	2
	Aug., 1874	11	10	7	1	5	36	12	11	0
	5	17	14	11	1	2	26	9	2	11
	6	11	14	4	3	6	42	2	11	0
	Sept., 1874	6	20	5	12	12	20	4	3	8
	5	19	22	2	2	5	25	4	1	10
	6	21	16	2	0	2	25	15	6	3
(12) Keokuk, Iowa	May, 1874	10	8	5	12	20	11	11	9	7
	5	7	15	4	8	18	21	11	5	4
	6	4	11	11	11	17	11	8	14	6
	June, 1874	10	5	11	15	17	11	9	3	9
	5	7	5	13	9	15	16	8	5	12
	6	10	14	13	13	15	4	4	14	3
	July, 1874	8	2	11	15	16	8	8	17	8
	5	4	5	3	22	6	7	9	13	24
	6	8	5	9	14	10	12	17	9	9
	Aug., 1874	14	2	3	12	6	17	17	12	10
	5	5	17	8	9	15	11	5	7	16
	6	13	4	4	5	24	18	14	9	2
	Sept., 1874	6	11	5	13	22	14	6	5	8
	5	11	10	6	14	16	5	5	9	14
	6	21	15	5	5	13	17	3	2	9
(13) La Crosse, Wis	May, 1874	18	8	6	8	33	5	4	11	0
	5	10	11	7	9	27	13	1	13	2
	6	14	7	9	10	28	9	5	9	2
	June, 1874	4	7	7	17	35	6	3	9	2
	5	10	15	5	13	16	17	3	10	1
	6	12	12	13	14	27	7	2	2	1
	July, 1874	10	13	5	17	31	8	2	3	4
	5	13	8	19	13	18	10	2	6	4
	6	15	9	4	11	36	6	1	6	5
	Aug., 1874	19	4	3	9	25	11	5	6	8
	5	14	9	13	1	36	8	2	6	4
	6	13	9	4	3	49	9	2	2	2
	Sept., 1874	8	11	5	5	40	3	2	3	10
	5	21	4	10	5	30	9	3	5	3
	6	21	10	5	3	27	4	5	10	5
(14) Leavenworth, Kans	May, 1874	18	6	1	3	31	9	2	8	10
	5	9	14	3	4	26	15	4	4	14
	6	7	6	5	7	30	14	6	11	7
	June, 1874	6	11	1	13	31	12	2	3	11
	5	9	7	2	3	44	8	4	5	4
	6	14	13	3	12	25	4	2	4	13
	July, 1874	13	1	0	6	43	9	5	5	11
	5	9	3	1	12	22	10	5	14	17
	6	6	3	2	6	31	10	4	5	26
	Aug., 1874	17	6	2	4	22	15	8	4	15
	5	12	11	0	4	20	11	2	2	31
	6	5	3	0	3	28	16	6	4	28
	S pt., 1874	9	9	1	2	25	13	7	1	23
	5	13	8	1	4	31	7	3	6	14
	6	11	18	2	1	26	8	3	2	19
(15) North Platte, Nebr	May, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	8	15	8	5	10	25	6	4	10
	6	10	8	5	8	9	30	3	13	7
	June, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	3	10	6	6	10	10	5	17	11
	6	20	15	7	4	7	14	3	6	14
	July, 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	2	7	2	8	7	14	2	15	36
	6	9	5	4	0	17	24	16	11	4
	Aug., 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	5	5	2	1	3	25	7	17	23
	6	4	4	2	4	11	40	15	9	4
	Sept., 1874	.....	.....	.....	.....	.....	.....	.....	.....	.....
	5	9	3	7	4	5	14	10	12	26
	6	11	13	8	1	5	20	12	10	10

Table of wind frequency, or number of times each wind was observed, &c.—Continued.

Station.	Date.	N.	N.W.	W.	S.W.	S.	S. E.	E.	N. E.	Calm.
(16) Omaha, Nebr	May, 1874	18	7	4	4	25	13	5	4	13
	5	7	12	1	8	19	22	6	2	16
	6	14	8	3	7	29	10	7	11	4
	June, 1874	9	16	5	7	35	9	3	1	5
	5	8	12	5	11	16	17	3	3	15
	6	22	15	3	5	23	9	0	4	9
	July, 1874	13	1	0	27	27	8	4	5	8
	5	16	9	2	9	11	17	2	8	19
	6	11	8	2	5	28	16	9	6	8
	Aug., 1874	16	3	1	7	19	15	2	9	21
	5	18	10	3	8	23	14	7	3	7
	6	12	4	0	2	34	23	2	2	14
	Sept., 1874	20	9	2	9	25	11	1	3	10
	5	15	13	3	9	26	13	4	2	5
	6	20	19	0	3	11	10	8	3	16
(17) Pembina, Dak	May, 1874	1	38	0	2	0	23	1	24	4
	5	7	22	5	3	5	33	4	4	10
	6	11	15	7	4	9	13	7	9	18
	June, 1874	0	22	0	7	0	31	1	17	12
	5	5	21	7	6	3	33	2	5	8
	6	12	21	7	8	7	12	1	12	10
	July, 1874	0	37	2	6	1	33	0	6	8
	5	14	16	8	11	18	10	2	5	9
	6	3	17	9	5	24	13	2	3	17
	Aug., 1874	0	24	0	8	0	36	0	6	19
	5	13	18	5	7	9	19	4	6	12
	6	9	14	8	1	17	23	2	0	19
	Sept., 1874	0	27	0	13	0	32	0	2	16
	5	13	14	12	5	11	9	5	6	15
	6	11	24	12	4	12	5	7	6	3
(18) Pike's Peak, Colo	May, 1874	17	14	25	12	13	4	4	2	2
	5	8	14	29	36	3	0	0	3	0
	6	7	15	27	24	2	2	2	14	0
	June, 1874	2	9	34	32	8	4	1	0	0
	5	2	17	26	34	5	0	0	5	1
	6	15	22	22	16	3	2	1	7	2
	July, 1874	7	5	7	23	17	6	8	19	1
	5	22	17	22	12	3	2	0	14	1
	6	9	11	19	26	3	1	4	16	1
	Aug., 1874	3	8	17	31	20	4	6	3	1
	5	26	21	7	23	0	1	1	14	0
	6	3	4	34	37	4	2	1	8	0
	Sept., 1874	18	13	17	20	4	3	4	11	0
	5	10	15	15	19	2	1	0	21	7
	6	9	11	44	17	3	1	0	4	1
(19) Sal Lake City, Utah	May, 1874	13	11	6	7	16	12	3	19	6
	5	2	8	9	9	5	15	16	15	14
	6	8	19	2	10	5	11	2	9	27
	June, 1874	7	18	1	2	12	17	7	22	4
	5	8	16	11	5	7	12	15	10	6
	6	13	9	2	1	2	4	19	19	21
	July, 1874	5	23	1	4	9	11	7	14	19
	5	24	14	2	8	7	12	6	16	4
	6	15	19	7	2	5	17	6	6	16
	Aug., 1874	5	8	0	7	10	17	11	14	21
	5	17	16	2	6	12	4	4	27	5
	6	15	19	5	0	10	21	8	7	8
	Sept., 1874	7	26	1	0	5	10	3	16	22
	5	12	15	3	7	12	9	7	18	7
	6	6	38	3	2	6	15	9	3	8
(20) Santa Fé, N. Mex	May, 1874	6	10	8	14	12	14	19	3	7
	5	14	4	6	23	14	9	12	5	6
	6	6	10	5	20	8	16	12	10	6
	June, 1874	7	7	7	16	8	20	11	6	8
	5	13	4	8	19	12	14	10	6	4
	6	4	8	5	19	5	10	12	10	17
	July, 1874	15	3	2	8	13	19	19	7	7
	5	17	6	5	14	13	11	9	7	11
	6	5	7	3	13	12	14	26	10	3
	Aug., 1874	17	10	4	16	6	14	12	7	7
	5	6	10	3	16	12	11	19	11	5
	6	12	6	3	14	8	16	15	10	9
	Sept., 1874	4	4	9	11	8	12	25	12	5
	5	13	7	4	17	9	21	7	7	5
	6	10	6	5	10	9	12	20	10	8

Table of wind frequency, or number of times each wind was observed, &c.—Continued.

Station.	Date.	N.	N.W.	W.	S.W.	S.	S.E.	E.	N.E.	Calm.
(21) Saint Louis, Mo.	May, 1874	16	12	2	13	25	14	8	2	1
	5	8	10	9	14	19	9	15	7	2
	6	8	5	6	22	19	6	15	8	4
	June, 1874	10	5	5	16	29	11	7	4	3
	5	8	6	11	18	21	9	5	8	2
	6	5	10	12	26	17	7	7	5	1
	July, 1874	21	4	8	13	26	3	5	11	2
	5	6	9	14	22	13	8	6	10	5
	6	7	5	8	17	26	7	10	12	1
	Aug., 1874	16	7	5	4	19	14	16	11	1
	5	12	10	9	15	24	5	4	11	3
	6	6	4	8	10	36	9	11	8	1
	Sept., 1874	12	6	4	3	27	24	9	3	2
	5	11	10	5	21	14	7	5	17	0
	6	20	13	3	16	19	1	5	9	4
(22) Saint Paul, Minn.	May, 1874	20	12	7	5	16	14	8	9	2
	5	6	17	6	7	8	30	3	6	10
	6	16	13	5	10	8	18	7	11	5
	June, 1874	8	9	6	6	16	26	11	5	3
	5	10	11	12	7	9	20	12	2	7
	6	8	22	11	15	8	16	3	3	1
	July, 1874	7	19	6	9	12	22	6	3	9
	5	11	18	7	14	15	11	3	6	8
	6	13	11	2	7	11	23	2	5	11
	Aug., 1874	12	9	3	6	5	31	15	7	5
	5	9	17	5	6	10	27	3	5	11
	6	3	11	9	2	16	35	7	2	8
	Sept., 1874	7	16	5	13	17	21	4	2	5
	5	16	14	6	5	10	24	3	3	9
	6	15	22	6	0	11	12	7	9	8
(23) Virginia City, Mont.	May, 1874	4	11	7	13	8	13	10	3	24
	5	4	11	18	20	1	13	0	7	19
	6	2	5	13	11	7	10	5	5	35
	June, 1874	6	16	10	15	6	7	3	1	26
	5	0	8	13	11	7	18	3	8	22
	6	1	6	21	7	7	19	5	4	20
	July, 1874	0	6	11	11	12	11	5	5	29
	5	1	8	8	4	7	19	11	15	20
	6	1	11	11	9	9	10	6	9	27
	Aug., 1874	5	4	7	9	15	15	6	5	27
	5	1	3	17	3	6	17	6	11	29
	6	2	5	14	8	5	12	8	6	33
	Sept., 1874	0	6	14	9	4	11	6	3	37
	5	1	10	14	5	3	31	9	7	10
	6	0	4	12	7	4	15	5	5	38
(24) Yankton, Dak.	May, 1874	8	13	7	10	20	8	9	16	2
	5	5	22	3	9	16	18	3	6	11
	6	7	9	5	5	13	24	15	7	9
	June, 1874	2	15	7	9	15	23	8	10	1
	5	8	15	7	8	5	20	10	12	5
	6	6	30	5	7	10	10	9	6	7
	July, 1874	5	10	4	22	7	16	9	16	4
	5	11	11	3	6	11	13	13	10	15
	6	4	7	2	5	31	21	7	7	9
	Aug., 1874	6	10	1	5	6	27	15	17	6
	5	8	17	2	6	15	21	6	5	13
	6	6	9	7	4	24	25	10	5	3
	Sept., 1874	2	20	2	11	11	16	7	9	12
	5	14	15	6	7	15	11	5	7	10
	6	5	31	6	2	9	13	15	6	3

In studying the preceding table we must bear in mind, on the one hand, the characteristics peculiar to each wind and each portion of our country; and, on the other, the needs and peculiarities of the locust. Of these latter, I apprehend that the important points accord with the following three hypotheses:

1. During the unfledged state the locust is killed by too low temperature or much rain. Now, the strong winds tend to scatter the insects further in the direction toward which they blow, and the cold and wet winds kill off the insects, preventing their increase on the side toward which *they* blow; the result is an apparent migration, which is simply an excess in the spreading of the insects by the strong winds.

2. A moist atmosphere, or one of rather high "relative humidity," prevents the wings

of the locust from properly drying after his fourth molt, but a clear, sunny day not only promotes this, but, if accompanied by a dry atmosphere, there is produced a rapid evaporation, a nervous irritating dryness and stiffness, or some other state that stimulates the locust to take recourse to flight. Once on the wing, however, he is borne by the prevailing wind. The migration thus initiated by the dryness of the wind is controlled by the strength of the wind, while it seems due to the volition of an intelligent animal in search of distant green pastures in the lower lands to the southward. The dry winds of the West are generally the N., NW., and W.

3. Conversely, the locusts hatched in moist lowlands find their molting stages retarded, and the full-fledged insect being uncomfortable with his partially-stiffened limbs and wings, takes to flight as a relief, and is again borne along by the wind; but it is now a moist wind that is bearing him onward.

The moist winds in the lower States (Missouri, &c.) are from the SW., S., and SE.; and as these are also largely prevalent, they produce the appearance of a return migration. The enfeebled condition of these lowland-born insects is apparently made up for by the greater frequency and strength of the winds; but only a few, and these, of course, the strongest, ever regain the Rocky Mountain breeding-grounds. It is, then, the relative humidity of the air that determines whether the locust will fly or not. Its nature is adapted to a certain range of atmospheric moisture; air drier or damper than this is uncomfortable to it.

These hypothetical views find some support in the following table, in which I have given, for each of our three epochs in locust-life, the year during which favorable and unfavorable winds were specially frequent at each locality, and by which, therefore, a judgment can be formed as to whether the years in question were any of them likely to be on the whole favorable to a grasshopper invasion. The conclusions are, of course, qualitative only and not quantitative, on account of the want of numerical data for the relative humidity, &c.

Years in which winds were frequently favorable or unfavorable to locust migrations.

State.	Station.	1. Spreading of unfledged locusts.				2. Migration of upland locusts.		3. Migration of lowland locusts.	
		Favorable.		Unfavorable.					
		Warm or dry winds.	Frequent in May.	Cold or wet winds.	Frequent in May.	Favorable warm dry winds.	Frequent in June and July.	Favorable warm moist winds.	Frequent in June and July.
Montana	(9) Fort Benton	W : SW.	1875	NE : N : NW.	1874, '5	SW : W : NW.	1874, '5 '6	.....	.....
	(23) Virginia City	W : SW.	1875	.....	.....	NW : W.	1874, '5, '6	.....	.....
Dakota	(1) Bismarck	S : SE : E.	1874, '5, '6	.....	.....	NW : W.	1874, '6	.....	.....
	(11) Fort Sully	SE : S : SW.	1876	.....	.....	N : NW.	1874, '6	.....	.....
	(17) Pembina	SE.	1875	NE : NW.	1874	NE : N : NW.	1874, '5, '6	.....	.....
	(24) Yankton	S : SE : E.	1876	NE : NW.	1874, '5	NW.	1876	.....	.....
Minnesota	(2) Breckenridge	SE : S : NW.	1874, '5, '6	.....	.....	N : NW : W.	1876	S : SE.	1874, '5, '6
	(22) Saint Paul	N : NW : SE.	1874, '5, '6	.....	.....	N : NW : W.	1876	SE : E.	1874, '5
Wisconsin	(13) La Crosse	S.	1874	.....	.....	N : NW.	1875, '6	SE.	1874, '5
Utah	(19) Salt Lake City	S : SE : E.	1874, '5, '6	.....	.....	NE : N : NW.	1874, '5, '6	.....	.....
Wyoming	(3) Cheyenne	S : E.	1874	NW : W.	1875	W : NW.	1875, '6	.....	.....
Kansas	(7) Dodge City	S : E.	1876	N.	1875	N : NW : W.	1876	S : SE : E.	1875, '6
	(14) Leavenworth	S : SE.	1874, '5, '6	N : NW.	1874, '5	N : NW : W.	1876	S.	1875
Nebraska	(15) North Platte	S : SE.	1875, '6	.....	.....	N : NW.	1876	SE.	1875
	(16) Omaha	S : SE : E.	1874, '5, '6	.....	.....	N : NW.	1876	S : SE.	1874
Iowa	(5) Davenport	SE : S : SW.	1874, '5, '6	.....	.....	NW : W.	1874, '6	SW : S.	1874, '6
	(8) Dubuque	SE : S : SW.	1 74, '5, '6	.....	.....	NW : W.	1875, '6	SW : S.	1876
	(12) Keokuk	SE : S : SW.	1874, '5, '6	.....	.....	N : NW : W.	1876	SW : S : SE.	1874, '5, '6
Colorado	(4) Colorado Springs	.....	.....	N.	1875, '6	N : NW : W.	1875	.....	.....
	(6) Denver	SW : SE.	1874, '5, '6	.....	.....	NE : N : W.	1874, '5	.....	.....
	(18) Pike's Peak	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico	(20) Santa Fé	SW — SE.	1874, '5, '6	.....	.....	N.	1875	.....	.....
Indian Territory	(10) Fort Gibson	SW : S : SE.	1874, '5, '6	.....	.....	.....	.....	E : SE : S : SW.	1874, '5, '6
Missouri	(21) Saint Louis	S : SE : E.	1875, '6	.....	.....	NW : W.	1875	SE : S : SW.	1874, '5, '6

CHAPTER VIII.

HABITS AND NATURAL HISTORY.

Numerous original observations on the habits and natural history, on the transformations and on the enemies of the Rocky Mountain locust, have been recorded in Mr. Riley's last three entomological reports to the State of Missouri, in our second bulletin, which was largely prepared therefrom, and in his "Locust Plague in the United States," as well as in other publications. In this and some of the succeeding chapters we shall have frequent occasion to use these facts, and prefer to do so as far as possible in the language in which they were originally recorded; but to avoid repeated reference to the same works, we shall simply use quotation marks, and the reader will understand that where other authority is not given, passages in quotation marks are from said writings. We do this the more readily that the Missouri reports are with difficulty obtained, and have had but a very limited circulation outside the State.

In treating of the habits of this insect we must needs do so from our own as well as the general experience; and since this has been almost entirely in the Mississippi Valley, the facts and generalizations that follow should be understood as applying more particularly to this region. We shall also have frequent occasion to use the terms *Permanent*, *Subpermanent*, and *Temporary* regions, that have already been explained (pp. 131–6), and are set forth in map 1. In treating of the habits and natural history of this insect, one thing has more particularly impressed us, viz, the difficulty of making absolute statements that will cover all seasons and all localities. The insect is so variable in its habits, and the conditions of climate and plant-growth are so different in different parts of the country affected, that what applies in one year or to one section will not apply in all years or to all sections. Hence the necessity of the regional classification just referred to, and the difficulty of laying down rules that have not exceptions.

DESTRUCTIVE POWER OF LOCUSTS.

No one who has not witnessed the ravaging power of locusts can fully conceive of or appreciate it. The organization and habit of the typical locust admirably fit it for ravenous work. Muscular, gregarious, with powerful jaws, and ample digestive and reproductive systems; strong of wing and assisted in flight by numerous air-sacs that buoy—all these traits conspire to make it the terrible engine of destruction which history shows it to have been under conditions favorable to its excessive multiplication. Insignificant individually but mighty collectively, locusts

fall upon a country like a plague or a blight. The farmer plows and plants. He cultivates in hope, watching his growing grain, in graceful, wave-like motion wafted to and fro by the warm summer winds. The green begins to golden; the harvest is at hand. Joy lightens his labor as the fruit of past toil is about to be realized. The day breaks with a smiling sun that sends his ripening rays through laden orchards and promising fields. Kine and stock of every sort are sleek with plenty, and all the earth seems glad. The day grows. Suddenly the sun's face is darkened, and clouds obscure the sky. The joy of the morn gives way to ominous fear. The day closes, and ravenous locust-swarms have fallen upon the land. The morrow comes, and, ah! what a change it brings! The fertile land of promise and plenty has become a desolate waste, and old Sol, even at his brightest, shines sadly through an atmosphere alive with myriads of glittering insects. The suffering in the country invaded in 1874, and the dreadful desolation the following spring, are sufficiently fresh in the minds of Western farmers, while the details given in Chapter III convey a fair idea of the magnitude of the loss inflicted.

Falling upon a cornfield, the insects convert in a few hours the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. "Covering each hill by hundreds; scrambling from row to row like a lot of young famished pigs let out to their trough; insignificant individually, but mighty collectively, they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and one can get some realization of the picture presented in many parts of the country west of the Mississippi during years of locust invasion.

"Their flight may be likened to an immense snow-storm, extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations, leaving the imagination to picture them indefinite distances beyond. 'When on the highest peaks of the Snowy Range, fourteen or fifteen thousand feet above the sea, I have seen them filling the air as much higher as they could be distinguished with a good field-glass.'[27] It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding upon the wind like an ominous hail storm, eddying and whirling about like the wild, dead leaves in an autumn storm, and finally sweeping up to and past you, with a power that is irresistible. They move mainly with the wind, and when there is no wind they whirl about in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, 'such as the approach of a thunder-storm or gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity, thousands being killed by the fall, if it is upon stone or other hard surface.'"[28]

[27] Wm. N. Byers, *Am. Entomologist*, I. p. 94.
[28] Wm. N. Byers, Hayden's Geol. Surv., 1870, p. 282.

An idea of the vast numbers that will sometimes descend to the ground may be formed by the following occurrence related to us by an intelligent and reliable eye-witness, Col. H. McAllister, of Colorado Springs, Colo.: In 1875, early in August, a swarm suddenly came down at that place. The insects came with the wind, and alighted in a rain. The ground was literally covered two and three inches deep, and glittered "as a new dollar" with the active multitude. In rising, the next day, by a common impulse, their wings would get entangled and they would drop to the ground again in a matted mass. "In alighting, they circle in myriads about you, beating against everything animate or inanimate; driving into open doors and windows; heaping about your feet and around your buildings; their jaws constantly at work biting and testing all things in seeking what they can devour. In the midst of the incessant buzz and noise which such a flight produces, in face of the unavoidable destruction everywhere going on, one is bewildered and awed at the collective power of the ravaging host, which calls to mind so forcibly the plagues of Egypt.

"The noise their myriad jaws make when engaged in their work of destruction can be realized by any one who has 'fought' a prairie fire, or heard the flames passing along before a brisk wind, the low crackling and rasping—the general effect of the two sounds is very much the same. Southey, in his Thalaba,[29] most graphically pictures this noise produced by the flight and approach of locusts:

> Onward they come, a dark, continuous cloud
> Of congregated myriads numberless,
> The rushing of whose wings was as the sound
> Of a broad river, headlong in its course
> Plunged from a mountain summit, or the roar
> Of a wild ocean in the autumn storm,
> Shattering its billows on a shore of rocks!

"Nothing, however, can surpass the prophet Joel's account of the appearance and ravages of these insects. Omitting the figurative parts, it is accurate and graphic beyond measure:

"'A day of darkness and of gloominess, a day of clouds and of thick darkness, as the morning spread upon the mountains; a great people and a strong; there hath not been ever the like, neither shall be any more after it, even to the years of many generations. A fire devoureth before them; and behind them a flame burneth; the land is as the garden of Eden before them, and behind them a desolate wilderness; yea, and nothing shall escape them. The appearance of them is as the appearance of horses; and as horsemen, so shall they run. Like the noise of chariots on the tops of mountains shall they leap, like the noise of a flame of fire that devoureth the stubble, as a strong people set in battle array. Before their face the people shall be much pained; all faces shall gather blackness. They shall run like mighty men; they shall climb the wall like men of war; and they shall march every one on his

[29] I., 169.

ways, and they shall not break their ranks. * * * They shall run to and fro in the city; they shall run upon the wall; they shall climb up upon the houses; they shall enter in at the windows like a thief.'"

Persons in the East have often smiled incredulously at our statements that the locusts often impeded the trains on the western railroads. Yet such was by no means an infrequent occurrence in 1874 and 1875—the insects passing over the track, or basking thereon so numerously that the oil from their crushed bodies reduced the traction so as to actually stop the train, especially on an up-grade.

While the destruction of crops by the winged insects is often sudden and complete, the unfledged insects still more effectually, though more slowly, denude a country of vegetation, sometimes rendering the ground as bare and desolate in midsummer as it is in the Mississippi Valley in midwinter. The little creatures are often so thick, soon after hatching, that they blacken everything, and their hopping, as one passes through a field or piece of prairie, gives the impression, at a short distance, as suggested by Mr. Whitman, of heat flickering in the air.

The migratory habit and great destructive power belong essentially to the Rocky Mountain locust.

As will appear from the two concluding chapters of this work, there are three or four very destructive and migratory species of locusts in Europe and Asia. There are also several other species which sometimes become very destructive, and still more rarely migrate from place to place in this country. Yet the Rocky Mountain locust is essentially the migratory and destructive species of North America, as none other compares with it in the vastness of its movements or the injury which it inflicts.

RATE AT WHICH LOCUST SWARMS MOVE.

The rate of migration of the winged insects will depend entirely on circumstances. The history of the past four years shows conclusively that the rate of progress of invading swarms from the permanent breeding-places will average about 20 miles a day. It is, however, exceedingly irregular, and greatly dependent on the velocity of the wind. Bad weather may impede, or adverse winds divert flight.

"One noticeable feature of the invasions is the greater rapidity with which the insects spread in the earlier part of the season, while in fullest vigor, and the reduction in the average rate of progress the farther east and south they extend. The length of their stay depends much upon circumstances. Early in the summer, when they first begin to pour down on the more fertile country, they seldom remain more than two or three days; whereas, later in the season, they stay much longer. In speaking of the advent and departure of these insects, I use relative language only. The first comers, when—after having devoured everything palatable—they take wing away, almost always leave a scattering rear-guard behind, and are generally followed by new swarms; and a

country once visited presents for weeks the spectacle of the insects gradually rising in the air between the hours of 9 or 10 a. m. and 3 p. m., and being carried away by the wind, while others are constantly dropping."

In short, the rate of spread is greatest during the first ten or fifteen days of their winged existence, or before the females become occupied with egg-laying. The invading insects are then passing the extensive plains and thinly-settled regions of the Northwest, where there is little inducement for them to halt, and the rate at such times, with strong and favorable wind, may reach a maximum of from two to three hundred miles a day.

The rate of spread of departing swarms from the temporary region is, as may be gathered from Chapter VII, very much the same. It is most rapid and direct early in the season when the insects first begin to leave more southern latitudes, and becomes more slack and inconstant as summer advances.

Extended flight does not take place till four or five days after the first insects become winged. For the first two or three days the newly-winged individuals mingle with the larvæ and pupæ, eating ravenously and making short flights of a few yards or rods, as if to try their wings, recalling fully the habit of native, non-migratory species. Then for a while they rise one by one higher in the air and float along with the wind, and finally, when weather and wind are favorable, all that are strong and mature enough rise as with a common impulse during the warmer morning hours and move off vigorously in one direction till they are soon out of sight. "They begin to rise when the dew has evaporated, and generally descend again toward evening. A swarm passing over a country yet infested with the mature insects, constantly receives accretions from these, and is, consequently, always more dense in the afternoon than in the forenoon. In rising, the insects generally face the wind, and it is doubtful if they could ascend to any great height without doing so."

The velocity of flight which, for many reasons, is quite distinct from the general movement understood by "rate of spread" or "migration," is naturally greater and will average about 10 miles an hour. It is also greatly dependent on the wind. Mr. S. S. Clevenger, of New Auburn, Minn., gives the average rate at 15 miles for that locality (App. 22); while the reports of other correspondents (App. 13) give the range from 4 to 40 miles, the more common rates mentioned being 12, 15, and 20 miles per hour. Mr. Brown Lusted, of Winnepeg, Manitoba, tells us that in 1867, when he was traveling from Saint Cloud, Minn., to Manitoba, the locusts were moving in the same direction, at from 30 to 35 miles a day. Professor Aughey's observations for 1877 (App. 8) give the rate per hour at 4 miles and upward; but he has himself expressed to us the belief that his estimates are somewhat low. We have ourselves never witnessed them flying so slowly as 4 miles per hour, which

must be considered the minimum rate where there is no impediment. When tacking against the wind, they may move not more than one mile,[30] while the maximum rate, in a strong wind, may reach as high as 50 miles or more per hour.

DIRECTION OF INVADING SWARMS.

While there may be, during an invasion, local flights in all possible directions (except, perhaps, due west), the general movement east of the mountains is conspicuously toward the south and southeast. The more local and irregular flights are generally made for food, but the more extended, southward movements are in obedience to other laws, discussed in the preceding chapter, and also on p. 250. West of the main Rocky Mountain range the rule of flight appears to be from the higher plains and plateaus, where the insect normally breeds, to the lower and more fertile valleys; and the greater irregularity of the prevailing winds and more broken nature of the country preclude the same regularity in directions of flight that, on the whole, prevails east of the range.

TIME OF APPEARANCE OF INVADING SWARMS.

"In endeavoring to deduce general conclusions respecting the time of year that the 1874 swarms reached different parts of the country, great difficulty was experienced in sifting those accounts which referred to the progeny of the 1873 invasion, and those which hatched within the insect's native range, and came from the extreme Northwest. The same was true of the fresh 1876 swarms, and those which hatched in Minnesota."

As a rule, the insects which hatch in the temporary region acquire wings, and leave before the fresh swarms from the mountain region appear. In the more northern regions, as in Minnesota and Manitoba westward, the insects hatched on the ground acquire wings the latter part of June and in July. The period is earlier as we go south, until in Southern Texas they are able to fly in April. The time of appearance of invading swarms from the permanent region is in inverse ratio, *i. e.*, earlier to the north and later to the south. Thus, while on the confines of the permanent region it is almost impossible to distinguish between the insects which hatch there and the fresh swarms from the Northwest, the difference becomes more and more marked toward the south and east.

"In 1874, swarms appeared during June in Southern Dakota; during July in Colorado, Nebraska, and Minnesota; during the latter part of this month in Iowa and Western Kansas. During August they came into Southeast Kansas and Missouri; and by the middle of October they reached Dallas, in Texas. In 1876 they came later."

[30] Mr. D F. Weymouth, of Lyon, Marshall County, Minn., records their going West in 1865, in "the teeth of a strong wind, making scarcely a mile an hour." See also p. 160, *ante*.

FLIGHT AT NIGHT.

"It is the very general experience throughout the country subject to invasion that the winged insects rise as soon as the sun begins to dissipate the dew, and that they come down again toward evening as the sun's rays lose their power. It is a question, therefore, whether they ever continue flying during the night, and one which future investigation will doubtless settle. I am of the opinion that during the warmer midsummer and early fall season, when the insects are departing from their northwest hatching-grounds, they must not infrequently continue flight from necessity; for the descent of a swarm borne along in a strong current of air, at an altitude of over a mile above the earth, will depend more on some change in strength or direction of the current than on any other condition of the atmosphere."

The experience we have been able to gather during the year on this point is confirmatory of the views expressed in the above passage, and in addition to the evidence brought forward in Chapter VII (p. 147) we may cite the following facts:

Two years ago the locusts were seen to rise about sundown, three miles north of this place, and to alight in Oak Township, this county. In August, 1874, Messrs. H. Lamb and L. Conger were at work on the steeple of the Methodist Church, in this town. Looking toward the sky they observed immense swarms of locusts going southwest for three consecutive days. They continued to pass up to 6 p. m., when the men left work, and none were heard of as alighting short of Mitchell and Smith Counties, in Kansas. The weather was dry, clear, and windy. The parties do not remember the exact days of the month, as they made no notes, but they are reliable, intelligent men.—(W. R. Follett, Malvern, Iowa, July 15, 1877.)

In one case, where the 'hoppers were very numerous, a person burnt a straw stack at night, and in the morning bushels of dead ones were found in and around it; perhaps they were drawn to it as the moth to a candle.—(W. J. Newell, Athol, Sioux County, Iowa, July 2, 1877.)

I never knew the insects to travel in sight during the night. They cannot, or will not, move in a heavy damp atmosphere. But that they remain in the atmosphere during the night seems almost certain, probably at a great height. There must be a period from the time the winged insects take flight until the time they commence depositing eggs when they remain for days and nights very high in the atmosphere out of sight. This seems evident from the fact that when they first commence flying, and until they are all gone, they rise in immense swarms during the early part of the day, but seldom many come down again.—(E. Snyder, Atchison, Kans., June 26, 1877.)

Mr. G. G. Hay, of Saint Andrews, Manitoba, informed us while staying with him that in traveling, in 1868, to Saint Paul, he noticed on one occasion that as soon as the sun was up the air was filled with locusts, though those which had descended the previous day did not rise for several hours afterward on account of the heavy dew. Mr. N. V. McDowell, of Worthington, Minn. (App. 17), states it as his experience that they fly all night with favorable wind. We were also informed at the conference of governers, in 1876, by a reporter of the Omaha *Herald*, whose name we have forgotten, that in order to test this question he had sent up a kite at night, covered on one side with tar, and that when

it was brought down it was literally covered with locusts. The most convincing experience, however, is that of Professor Aughey's, given in Chapter VII. In camping on the Bow River, in August, 1866, the wind, which was blowing from the northwest, suddenly changed to north soon after midnight, and locusts were heard pattering on his tent, and the insects were found thick the next morning where none had been seen the day before.

Singularly enough we get no information from European writers on the question of flight at night.

That locusts are capable of long-sustained flight is evident from the well-authenticated instances of their being observed at sea hundreds of miles from land. One of the most striking instances is that recorded by Master E. G. Wiswell, of the Harrisburg. When this vessel, November 2, 1865, was in latitude 25° 28′ north, longitude 41° 33′ west, on her way from Bordeaux to New Orleans, the nearest land being about 1,200 miles, she was boarded during a heavy rain-storm by large numbers of locusts that filled the air and covered the sails. The specimens were subsequently determined to be the European *Acridium peregrinum* by Mr. S. H. Scudder, who records the facts.

HEIGHT OF FLIGHT.

This subject has already been considered in Chapter VII (p. 144). There is no doubt whatever that the insects often move over a country entirely above the reach of human vision. In ordinary flights we observe only the lower individuals, and in looking toward the sun we may always observe others, farther and farther away, until the glittering specks are lost to sight. In cloudy weather they are not noticeable unless very dense, so as to darken the atmosphere, until within about 1 000 feet; yet it is well known that they fly at times nearly, if not full, two miles above ground, as they have been seen flying toward the plains as high above the highest peaks of the Rocky Mountains as a good telescope would resolve them.

GENERAL HABITS AT NIGHT.

Regarding the general habits of the species at night, a glance at the experience obtained in answer to our circulars (App. 17) is sufficient to show that it differs widely and is often contradictory. This is not surprising, as so much in the habits and ways of our locust depends on conditions of the weather, season, &c. We have had an extensive experience both with the unfledged and full-fledged insects, and the result of it is that, as a rule, the young insects are quiet at night, either hiding under some shelter upon the ground, or roosting away from the ground. The former is more apt to be the case in cold, the latter in wet weather. In cool weather even the mature insects do not feed at night, but when the weather is warm and dry these are often as ravenous dur-

ing the night as during the day. Gerstaecker remarks of the European *migratoria* that it feeds most at night.

As the insects advance in age the roosting habit becomes greater, and for a few days after getting wings the mature insects delight to gather away from the ground, especially on trees.

INTERVAL BETWEEN ACQUIRING FULL WINGS AND EGG-LAYING.

This will of course vary according to surrounding conditions, and may be said to average from two to four weeks. Exact data are with great difficulty obtained, since it is always impossible to know the exact age of winged insects when captured, and the species is not easily reared from the immature states in confinement, especially east of its natural range. Mr. Whitman, who at Saint Paul, Minn., is just within its range, has made the only exact experiment that bears on this point, and gives it in the following words, in his special report for 1876:

> On the 25th of June I shut up in wire-gauze cages nine pupæ of the Rocky Mountain locusts. The bottoms of the cages were filled with earth packed hard, and the insects appeared to thrive in confinement. By the 2d of July they had all become perfect insects. By the 8th of July they commenced coupling, and were seen repeating the act for several days. On the 15th and 16th, two of the females went through the form of depositing eggs, and I marked the place of deposit on the edge of the cage. The coupling was repeated again as before, until the 3d of August. At that date the coupling ended, and the locusts became almost inactive, and were seen to eat very rarely afterward.

The following facts from notes made by us on other species common around Saint Louis, will also throw light on the subject. In two instances where the eggs were obtained from the same individuals that were observed to go through the last molt, the interval varied from about one to three weeks in species of the same genus; while in the others, which are approximately correct, it varies from one to six weeks.

Caloptenus atlanis, Riley.—Mature insects first noticed July 12. Eggs deposited July 18.

C. femur-rubrum, Burm.—Became winged August 20. Eggs laid October 3.

C. turida, Dodge.—First winged insects captured August 25. Eggs deposited September 17.

C. bivittatus, (Say.)—First winged insects noticed July 7. Eggs deposited August 31.

C. differentialis, Thom.—First winged specimens obtained July 19. Eggs laid September 9.

Pezotettix viola, Thom.—Mature insects first noticed August 18. Eggs laid by same specimens on the 24th of August.

P. unicolor, Thomas.—Attained maturity about the 1st of September. Eggs laid by same specimens on the 24th same month.

Chrysochraon viridis, Scudder.—Mature insects first noticed July 7. Eggs deposited August 20.

Tragocephala viridifasciata, Göze.—Mature insects captured May 2. Eggs deposited June 11.

Œdipoda carolina, (Linn.)—Mature insects captured July 12. Eggs deposited August 6

O. sulphurea, Burm.—Mature insects captured September 19. Eggs deposited September 28.

O. phœnicoptera, Germ.—Mature insects captured June 20. Eggs deposited July 13.

Eucoptolophus sordida, Burm.—Mature insects first noticed September 19. Eggs deposited September 24.

E. costalis, Scudd.—Mature insects first noticed September 20. Eggs laid September 24.

Acridium americanum (Drury.)–Mature insects captured June 14. Eggs deposited June 24.

SEXUAL HABITS.

There are various questions coming under this head that have a scientific bearing, but do not materially concern the farmer. We shall treat them very briefly. The love-season may be said to commence just as soon as all the parts of the full-winged individuals have become hardened and perfected and to endure till near death. Nevertheless, the most active and ardent period occurs during the first two or three weeks after maturity, and it is during this period, also, that the migrating instinct is most developed. Every one who has closely observed these insects is aware that they are salacious in habit. We have often noticed (in *Caloptenus differentialis*, *C. femur-rubrum*, and *C. atlanis*) a pair in our vivaria that were in copula at evening still together the following morning, and in some instances till toward noon, thus showing that coition may last from 12 to 18 hours. It also ordinarily takes place in a very few days after maturity. The following notes by Mr. Packard bear on this point:

SALEM, MASS., *July* 31.—A couple of *C. bivittatus* found *in copula* was put in confinement, and remained united from 10.45 a. m. until 5.30 p. m., when I went away. The next morning at 8.30 they were separate.

On the same day two pairs were taken *in copula* and thus remained in confinement from 11.45 a. m. until 5.30 p. m., when I went away.

Another pair remained in confinement *in copula* from 10.30 till 1 p. m.

The female frequently moves about and feeds during the act, but the male, which either rides upon her or hangs more or less at the side, remains motionless unless at the approach of another male, when he moves the hind legs and goes through the fiddling process. We have known the males to perish in the act, and late in the season, when the last locusts were overtaken by a severe frost or snow-storm which destroyed them, we have seen many of them perish in pairs.

That coition is frequently repeated there can also be no doubt, as this is the general experience regarding European species; and we have known females which had already oviposited to receive the male again. It is also quite common for the male to wait on the female while she is in the act of ovipositing. That the locusts are polyandrous there can be just as little doubt; for though actual observation is wanting, it is not uncommon to find the same female attended by other males, even while yet coupled. Körte, who made very careful observations on the European *migratoria* in confinement, records[31] that one female coupled, between August 26 and September 11, with six different males, and laid

[31] Die Strich-, Zug-, oder Wanderheuschrecke, vom Eie an beobachtet. Berlin, 1829.

eggs on September 12. She then coupled again several times, and laid a second time September 17. Under similar conditions she laid altogether at six different periods before dying.

WHERE THE EGGS ARE LAID.

"The eggs may be laid in almost any kind of soil, but by preference they are laid in bare, sandy places, especially on high, dry ground, which is tolerably compact and not loose. It is often stated that they are not laid in meadows and pastures, and that hard road-tracks are preferred; in truth, however, meadows, and pastures, where the grass is closely grazed, are much used for ovipositing by the female, while on well-traveled roads she seldom gets time to fulfill the act without being disturbed. Thus a well-traveled road may present the appearance of being perfectly honey-combed with holes, when an examination will show that most of them are unfinished and contain no eggs; whereas a field covered with grass-stubble may show no signs of such holes and yet abound with eggs." In fact, wherever holes are noticed, it may generally be taken for granted that they contain no eggs, for the mother covers well the hole when she has time to properly complete her task.

"Furthermore, the insects are more readily noticed at their work along roads and road-sides than in fields, a fact which has also had something to do in forming the popular impression. Newly-plowed land is not liked; it presents too loose a surface; but newly-broken sward is often filled with eggs. Moist or wet ground is generally avoided for the purpose under consideration."

We have noticed that in the Permanent breeding-region, wherever the vegetation is scant the females show a decided preference for the shaded base of shrubby plants, among the roots of which they like to place their eggs; whereas in the Temporary region, where the vegetation is generally so much ranker, exposed situations, or those comparatively bare of vegetation, are preferred. The experience of 1876 proved very conclusively, also, that they are instinctively guided toward cultivated fields, where the young will find good pasturage; for the eggs were noticeably thickest, and hatched most numerously in 1877 in cultivated areas. In the Cypress Hills region of British America, as Mr. J. G. Kittson informs us, the high lands and protected slopes of the hills are preferred. The soil of the mountain-region, where the insects permanently breed, is mostly of a compact, scantily-covered, gravelly nature, and the notion that they lay most in pure sand is an erroneous one.

Sandy soil that is compact, especially when having a south or east exposure, is much chosen, but in loose and shifting sand the eggs would perish. In 1876, it was generally remarked that the insects were more indifferent than usual in ovipositing, and that eggs were much more frequently laid in low, and even wet, land than in former years.

The mass seldom reaches more than an inch below the surface, except where some vegetable root has been followed down and devoured, and

the insect leaves her eggs before emerging; in this way the mass is sometimes placed a foot below the surface. In abnormal or unhealthy conditions, the eggs may be laid in exposed places without any hole, in which case they doubtless never give birth to young. In other cases, the female will fill her hole almost entirely with the sebific matter. Nor are the eggs invariably laid in the ground, for while we know of no exceptions to this normal position in *spretus*, yet Mr. Boll informs us that around Dallas, Tex., in 1876, the eggs of *differentialis* were very numerously placed under the bark of elm and hackberry logs that had been felled on low land. We have also received from A. W. Hoffmeister, of Fort Madison, Iowa, the eggs of a species of *Stenobothrus*, and the young that hatched from them, the eggs having been thrust into holes made by some carpenter-bee in a fence-post; while *Chlöealtis conspersa* habitually bores in dead wood.

MANNER IN WHICH THE EGGS ARE LAID.

"The female, when about to lay her eggs, forces a hole in the ground by means of the two pairs of horny valves which open and shut at the tip of her abdomen, and which, from their peculiar structure, are admirably fitted for the purpose. (See Fig. 2, where *b*, *c*, show the structure of one of each of the upper and lower valves.) With the valves closed she pushes the tips into the ground, and by a series of muscular efforts and the continued opening and shutting of the valves she drills a hole, until in a few minutes (the time varying with the nature of the soil) nearly the whole abdomen is buried. The abdomen stretches to its utmost for this purpose, especially at the middle, and the hole is generally a little curved, and always more or less oblique (Fig. 1, *d*). Now, with hind legs hoisted straight above the back, and the shanks hugging more or less closely the thighs, she commences ovipositing."

FIG. 1: ROCKY MOUNTAIN LOCUST.—*a*, *a*, *a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open; *c*, a few eggs lying loose on the ground; *d*, *e*, show the earth partially removed, to illustrate an egg-mass already in place, and one being placed; *f*, shows where such a mass has been covered up. (After Riley.)

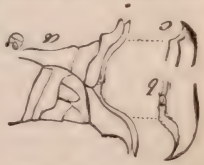

FIG. 2: ROCKY MOUNTAIN LOCUST.—Anal characters of female, showing horny valves. (After Riley.)

When the hole is once drilled there exudes from the tip of the body a frothy, mucous matter, which fills up the bottom of the hole, and bathes the horny valves. This is the sebific fluid which is secreted by the sebific or cement gland described with the other anatomical details given in Chapter IX. By repeatedly extricating and studying

specimens in every possible stage of oviposition, we have been able to ascertain the exact method by which the egg-mass is formed. The process has never been accurately described by other writers, and the general impression—upon which figures like those of Gerstäcker's[32] are founded—is that the eggs are extruded from between the distended hooks or valves. If we could manage to watch a female from the time the bottom of her hole is moistened by the sebific fluid, we should see the valves all brought together, when an egg would pass down the oviduct (Fig. 3, *j*) along the ventral side, and, guided by a little finger-like style (the *gubernaculum ovi*, *g*), "pass in between the horny valves (which are admirably constructed, not only for drilling but for holding and conducting the egg to its appropriate place), and issue at their tips amid the mucous fluid already spoken of. Then follows a period of convulsions, during which more mucous material is elaborated, until the whole end of the body is bathed in it, when another egg passes down and is placed in position. These alternate processes continue until the full complement of eggs are in place, the number ranging from 20 to 35, but averaging about 28. The mucous matter binds all the eggs in a mass, and when the last is laid, the mother devotes some time to filling up the somewhat narrower neck of the burrow with a compact and cellulose mass of the same material, which, though light and easily penetrated, is more or less impervious to water, and forms a very excellent protection (Fig. —, *d*)." When fresh the mass is soft and moist, but it soon acquires a firm consistency.

FIG. 3.—OVIPOSITION OF ROCKY MOUNTAIN LOCUST. (After Riley.)

"During the operation the female is very intent on her work, and may be gently approached without becoming alarmed, though when suddenly disturbed she makes great efforts to get away, and extricates her abdomen in the course of a few seconds, the time depending on the depth reached."

The legs are almost always hoisted straight above the back during the process, as shown in the figure (Fig. 1), with the shanks hugging more or less closely the thighs. Sometimes, however, especially when the abdomen is fully buried, the ends of the hind feet may rest firmly on the ground, as has been observed by Mr. Packard in the case of *femur-rubrum*.

"The time required for drilling the hole and completing the pod will vary according to the season and the temperature. During the latter part of October or early in November, 1876, when there was frost at night and the insects did not rouse from their chilled inactivity until 9 o'clock a. m., the females scarce had time to complete the process during the four or five warmer hours of the day; but with higher temperature not more than from two to three hours would be required."

[32] Die Wanderheuschrecke, Berlin, 1876, Taf. II, Fig. 4.

We have been for weeks with the insects where they were so thickly ovipositing that the light, clay-yellow ground would be darkened by them, and have laid on a closely-grazed sward for hours with specimens in the act all around, and have repeatedly verified all that we have here described.

PHILOSOPHY OF THE EGG-MASS.

"To the casual observer, the eggs of our locust appear to be thrust indiscriminately into the hole made for their reception. A more careful study of the egg-mass, or egg-pod, will show, however, that the female took great pains to arrange them, not only so as to economize as much space as possible, consistent with the form of each egg, but so as to best facilitate the escape of the young locust; for if, from whatever cause, the upper eggs should fail to hatch, or should hatch later than the lower ones, the former would offer an impediment to the exit of the young in their endeavors to escape from these last, were there no provision against such a possibility. The eggs are, indeed, most carefully placed side by side in four rows, each row generally containing seven. They oblique a little crosswise of the cylinder (Fig. 4, *a*). The posterior or narrow end, which issues first from the oviduct, is thickened, and generally shows two pale rings around the darker tip (Fig. 4, *b*). This is pushed close against the bottom of the burrow, which, being cylindrical, does not permit the outer or two side rows to be pushed quite so far down as the two inner rows, and for the very same reason the upper or head ends of the outer rows are necessarily bent to the same extent over the inner rows, the eggs when laid being somewhat soft and plastic. There is, consequently, an irregular channel along the top of the mass (Fig. 4, *c*), which is filled only with the same frothy matter that surrounds each egg, which matter occupies all the other space in the burrow not occupied by the eggs. The whole plan is seen at once by a reference to the accompanying figure, which represents, enlarged, a side view of the mass within the burrow (*a*), and a bottom (*b*) and top (*c*) view of the same, with the earth which adheres to it removed."

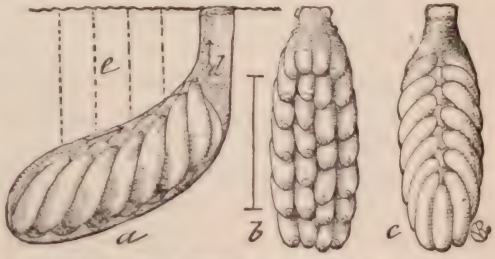

FIG. 4: EGG-MASS OF ROCKY MOUNTAIN LOCUST—*a*, from the side, within burrow; *b*, from beneath; *c*, from above, enlarged. (After Riley.)

This same quadrilinear arrangement of the eggs occurs, also, in the egg-mass of the Red-legged and Lesser locusts, and in most of the species of medium size which we have studied, including several different genera. Yet it is by no means constant in the same genus, since, as we shall see in Chapter XI, the eggs of *Caloptenus differentialis* (Pl. IV, Fig. 1) are irregularly arranged. This irregular arrangement also occurs in

the eggs of *Œdipoda phaneœoptera* and *Acridium Americanum*, and in these species the cement which binds the eggs together is more copious than in the others.[33] In one narrow-bodied species (*Eucoptolophus sordidus*) the eggs are arranged in but three rows.

Even in the pods of those species which have the eggs irregularly arranged the head ends point either mostly outward (*differentialis*) or inward (*Americanum*), so that the young locusts may either push out at the sides or through a central space.

The length of the neck, or that portion containing no eggs, varies not only in different species but in different masses of the same species.

DOES THE FEMALE LAY MORE THAN ONE EGG-MASS?

This is a question often asked, but which the average farmer has no means of definitely answering. "It is the rule with insects, particularly with the large number of injurious species belonging to the Lepidoptera, that the eggs in the ovaries develop almost simultaneously, and that when oviposition once commences it is continued uninterruptedly until the supply of eggs is exhausted. Yet there are many notable exceptions to the rule among injurious species, as in the cases of the common Plum-curculio and the Colorado potato-beetle, which oviposit at stated or irregular intervals during several weeks, or even months. The Rocky Mountain locust belongs to this last category, and the most casual examination of the ovaries in a female, taken in the act of ovipositing, will show that, besides the batch of fully-formed eggs then and there being laid, there are other sets, diminishing in size, which are to be laid at future periods. This, I repeat, can be determined by any one who will take the trouble to carefully examine a few females when laying. But just how often or how many eggs each one lays is more difficult to determine. With *spretus* I have been able to make comparatively few experiments; but on three different occasions I obtained two pods from single females, laid at intervals of eighteen, twenty-one, and twenty-six days, respectively. I have, however, made extended experiments with its close congeners, *femur-rubrum* and *atlanis*, and in two cases, with the former, have obtained four different pods from one female, the laying covering periods of fifty-eight and sixty-two days, and the total number of eggs laid being 96 in the one case and 110 in the other. A number of both species laid three times, but most of them—owing, perhaps, to their being confined—laid but twice."

Yersin concludes, referring to the European *migratoria*, that eggs are laid thrice, at intervals of about a month, while Krünitz, Keferstein, and Stoikowitsch[34] also declare that they are laid in three different masses. Professor Whitman, in his 1876 experiments, had a female

[33] The species occurring around Saint Louis in the eggs of which we have noticed the same quadrilinear arrangement as in those of *spretus*, etc., aside from those already mentioned *Caloptenus bivittatus*, *Pezotettix rubi*, *P. unicolor*, *Chrysochraon viridis*, *Tragocephala viridifasciata*, *Œdipoda carolina*, *Œ. sulfurea*, and *Eucoptolophus costalis*.

[34] See Köppen, p. 35.

which laid about the middle of July, and died September 9, without laying again, though eggs were found in the ovaries at death. The time between the first and second laying, observed by Körte, was six days. Mr. Aughey (App. 8), from experiments made in 1876, found the interval still shorter, ranging from two to three days; but he requests us to add that other experiments, not recorded, showed a much longer interval between the periods, extending in some cases to twenty days. It would thus appear that there is the greatest diversity in the time intervening between the periods of egg-laying, and that the number of egg-masses formed by one individual is by no means constant. It is natural to suppose that there will be great difference in individual prolificacy, and we are also of the opinion that there is great difference in this respect in different generations—those that hatch in the Permanent region being more prolific than those which hatch in the Temporary region. This opinion is not only warranted by the general experience of farmers, but also by experiment. As compared with those of 1876, the autumn flights of 1877 were for the most part intestate, and it was very generally noticed that they laid no eggs. (App. 12.) There is, as we have seen in the preceding chapter, the best of reasons for believing that these flights were not from the Permanent region, but consisted mainly of insects that had bred in the Temporary region.

It is well known that the reproductive organs are easily affected by any sudden change of climatic conditions which animals may be subjected to, and that sterility is one of the most frequent consequences of such change. It was upon this general rule that the late B. D. Walsh, knowing nothing of the return migration, based the theory that the Rocky Mountain locust could never thrive in the temporary region, but would become intestate and perish there. In 1876 we had measurable success in getting *spretus* to lay eggs in confinement. In 1877, though we made far more strenuous efforts with the insects that hatched in Texas and Kansas, yet we signally failed. Of many thousands which we hatched in Saint Louis and endeavored to rear under the most favorable circumstances in vivaria containing growing grain, most of them died in from three to eight days from hatching. We succeeded in bringing a few through the third and two through the fourth molt. At Carbondale, Ill., from Minnesota eggs, Mr. Thomas had better luck, and reared several to the winged condition. We repeatedly dispatched living specimens both of the pupæ and the mature insects from Texas, Kansas, and Iowa, to our office-clerk, Mr. Th. Pergande, Saint Louis; but with no more favorable results, as he entirely failed to obtain eggs, and the females, when dead, were found, upon examination, to contain none. This want of fecundity, though not universal, was quite general with the insects of 1877, and is in keeping with the general experience as to the sickly and degenerate nature of the brood.

It is quite manifest, therefore, that in answering the question we have just asked we can do so only in a general and qualified manner. The num-

ber of eggs produced by a well-developed locust will range from 100 to 150, if we consider species generally. We have counted 171 in one mass of *Caloptenus differentialis;* from 120 to 130 in those of *Œdipoda phanæcoptera,* and about 120 in that of *Acridium Americanum.* The great probability is that the eggs of such species are all laid at once. In species like *spretus,* which rarely lay more than 30 eggs in one mass, it were natural to infer that different layings take place, even did the facts at hand not prove such to be the case. In 1876 the insects were pushing continuously southward from the middle of August till the end of October, and during most of this time they were laying eggs. In fact, throughout the country invaded, from Minnesota to South Texas, they continued laying till frost, and we know from examinations that many of them perished before all the ova had been disposed of. Stragglers were even noticed in Texas as late as December.

To sum up the inquiry, we would give it as our belief that the laying season normally extends from six to eight weeks; that it may be shortened or lengthened by conditions of weather and climate; that fecundity is materially affected by the same conditions; that the average number of egg-masses formed is three; and that the average interval between the periods of laying by the same female is two weeks.

THE HATCHING PROCESS.

All that pertains to embryology proper will be found in Chapter IX, and we shall make here but a brief reference to the character of the egg in order to more clearly illustrate the process of hatching. "Carefully examined, the egg-shell is found to consist of two layers. The outer layer, which is thin, semi-opaque, and gives the pale, cream-yellow color, is seen by aid of a high magnifying power to be densely, minutely, and shallowly pitted; or, to use still more exact language, the whole surface is netted with minute and more or less irregular, hexagonal ridges (Fig. 5, *a*, *b*). It is a mere covering of excreted matter, similar in nature to the mucous or sebific fluid already described, which binds the eggs together. The inner layer (or *chorion*) is thicker, of a deeper yellow, and perfectly smooth. It is also translucent, so that, as the hatching period approaches, the form and members of the embryon may be distinctly discerned through

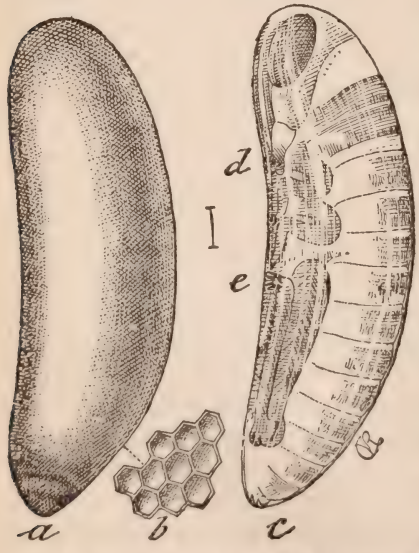

FIG. 5.—EGG OF ROCKY MOUNTAIN LOCUST.—*a*, showing sculpture of outer shell; *b*, the same, very highly magnified; *c*, the inner shell, just before hatching.—(After Riley.)

it. The outer covering is easily ruptured, and is rendered all the more fragile by freezing; but the inner covering is so tough that a very strong pressure between one's thumb and finger is required to burst it. How, then, will the embryon, which fills it so compactly that there is scarcely room for motion, succeed in escaping from such a prison? The rigid shell of the bird's egg is easily cracked by the beak of its tenant; the hatching caterpillar, curled within its egg-shell, has room enough to move its jaws and eat its way out; the egg-coverings of many insects are so delicate and frail that the mere swelling of the embryon affords means of escape; those of others are so constructed that a door flies open, or a lid lifts by a spring, whenever pressure is brought to bear; in some two halves open, as in the shell of a muscle; whilst in a host of others the embryon is furnished with a special structure called the egg-burster, the office of which is to cut or rupture the shell, and thus afford means of escape. But our young locust is deprived of all such contrivances, and must have another mode of exit from its tough and sub-elastic prison. Nature accomplishes the same end in many different ways. She is rich in contrivances. The same warmth and moisture which promote the development of the living embryon also weaken the inanimate shell, by a process analogous to decomposition, and by a general expansion consequent upon the swelling of the embryon within. Thus, the eggs when about to hatch are much more plump and somewhat larger and more transparent than they were when laid. At last, by the muscular efforts of the nascent locust, and the swelling of its several parts, especially about the head and mouth, the shell gives way, generally splitting along the anterior ventral part. The whole process may, in fact, be likened to the germination of a hard-covered seed, when planted in moist ground, and, precisely as in this latter case, there is in some loose soils a certain heaving of the ground from the united swelling of the locust eggs. All the eggs in a given mass burst very nearly at one and the same time, and in that event the lowermost individuals await the escape of those in front of them, which first push their way out through the neck of the burrow (Fig. 4, *d*) provided by the parent.

"They all escape, one after the other, through one small hole, which in the field is scarcely noticeable. Such is the usual mode of hatching; but when the young from the lower eggs hatch first, or when the upper eggs perish and leave the lower ones sound—as is not unfrequently the case—the exit is nevertheless easily made along the channel already described (Fig. 4, *c*)."[35]

When once the shell is ruptured the nascent larva soon succeeds, by a series of undulating movements, in working free therefrom and making its way to the light in the manner just described. Once on the surface of the ground it rests for a few minutes, generally lying on the side. Its members are still limp and directed backward, and it is yet enveloped

[35] For fuller details respecting the mode of the escape of the nascent locust from the egg, the reader is referred to Chapter IX.

in a very delicate film or pellicle (*amnion*, see Chap. IX), which must be cast off before the little creature can move with alacrity.

By continuance of similar contracting and expanding movements which freed the animal from the earth, this film in a very short time splits along the middle of the back near the head (strictly the prothorax), and is then worked off behind, and finally kicked from the hind feet in a little white crumpled pellet, that has justly been likened by some of our correspondents to a diminutive mushroom. These little pellets invariably lie close around the hole in the ground from which the young locusts issued. The pellicle begins to split, under ordinary conditions of warmth, within a minute from the time the locust is fairly out of the ground, and is shed in from one to five minutes, according to circumstances. Pale and colorless when first freed from this pellicle, the full-born locust is nevertheless at once capable of considerable activity, and in the course of an hour assumes its natural dark gray coloring. Mr. Packard observed (Report to Dr. Hayden, 1877, p. 634) that specimens which hatched at 11 a. m. began to turn dark at 3 p. m., thus showing that the time may vary; but numerous close observations which we have made on single individuals show that an hour seldom passes after the amnion is thrown off before the gray color is acquired.

"From this account of the hatching process, we can readily understand why the female in ovipositing prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

"Though the covering which envelops the little animal when first it issues from the egg is quite delicate, it nevertheless, in the struggles of birth, undoubtedly affords much protection, and it is an interesting fact that while, as we have just seen, it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed if, from one cause or other, there is failure to escape from the soil, even though the young locust may be struggling for days to effect an escape.

"While yet enveloped in this pellicle, the animal possesses great forcing and pushing power, and if the soil be not too compact, will frequently force a direct passage through the same to the surface, as indicated at the dotted lines, Fig. 4 *e*. But if the soil is at all compressed it can make little or no headway, except through the appropriate channel (*d*). While crowding its way out the antennæ and four front legs are held in much the same position as within the egg, the hind legs being generally stretched. But the members bend in every conceivable way, and where several are endeavoring to work through any particular passage, the amount of squeezing and crowding they will endure is something remarkable. Yet if by chance the protecting pellicle is worked off before issuing from the ground, the animal loses all power of further forcing its way out. The instinctive tendency to push upward is also remarkable. In glass tubes, in which I have had the eggs hatching in order to watch the young, these last would always turn their heads and push

toward the bottom whenever the tubes were turned mouth downward; while in tin boxes, where the eggs were placed at different depths in the ground, the young never descended, even when they were unable to ascend on account of the compactness of the soil above."

WHERE AND UNDER WHAT CONDITIONS OF SOIL THE YOUNG HATCH MOST FREELY.

As may be gathered from a series of experiments recorded in Chapter XIII, the eggs will hatch under the most varied conditions. As a rule, the soils and locations preferred by the female in ovipositing will be those in which the young will most freely hatch, viz, compact and sandy or gravelly knolls and hillsides, with a south or southeast exposure.

The experience of 1877 (App. 18) shows also that hatching takes place very freely in late-mown meadows or prairies, or grazed pastures, where the exposure of the ground permits ready oviposition, and the warmth of the sun. In dry, well-drained, and compact soils of a light nature the eggs are much better preserved than in heavy clays and loams, where they are more subject to mold and rot. The experience of 1877 is rather misleading on this point, and indicates the necessity of generalizing, not from the experience of one, but of many years. The insects were most numerous, and seemed to hatch most numerously in the low lands and in sheltered situations along river-courses. The facts are that in such situations those which did hatch survived in larger proportions than did those which hatched in more exposed places, because the former were better protected from the cold rains and storms of spring.

TIME OF HATCHING.

Here, again, we cannot take the experience of any one year as a guide, but find the necessity of generalizing from all past experience. In much of the locust area there prevailed such late warm weather in the autumn of 1876 that considerable numbers of the young hatched prematurely, and such is very generally the case. We had also some unseasonably warm weather in January and February, 1877, during which large numbers hatched. These all subsequently perished. During the latter part of March and early in April the hatching was general, but there followed a period of cold, rainy weather, which checked the hatching and destroyed a large number of the insects that had hatched. May and June were characterized by abundant rains and storms, alternating with warm, sunny weather, causing the hatching to be irregular, and in some cases quite retarded. It would not be incorrect, therefore, to say (App. 18) that in one and the same neighborhood the hatching commenced on the 1st of February, and did not cease till the end of June, thus covering a period of five months. Yet this is exceptional, and it has been much more regular and the period more restricted in previous years.

Those eggs which are laid earliest the previous year will also hatch

earliest (App. 1), and since, as we have already seen (*ante* p. 228) the egg-laying covers an average period of six or eight weeks in the same locality, and lasts generally till frost, it follows that the eggs pass the winter in every state of development—some with the fluids clear and limpid; others with the embryo fully formed and ready at the first approach of spring to hatch. This we found also to be actually the case, for many hundreds of egg-masses examined during the winter of 1876–'77, from divers parts of the infested region, showed every state of development.

In the same locality hatching will take place—*cæteris paribus*—first on light dry soils and on south and southeast exposures; latest on low, moist, and shaded or tenacious ground.

We see, therefore, that the hatching will not alone vary according to temperature and the earliness or lateness of the spring, but that it is quite variable under the same conditions. In every instance there will be a few hatching when the first hatched in the same locality are getting wings, and we give it as a general rule that the bulk of the eggs hatch out in the different latitudes about as follows:

In Texas, from the middle to the last of March.

In the southern portions of Missouri and Kansas, about the second week in April.

In the northern parts of Missouri and Kansas and the southern sections of Iowa and Nebraska, the latter part of April and first of May.

In Minnesota and Dakota, the usual time of hatching ranges from early in May in the southern portions to the third week in the northern extremity.

In Montana and Manitoba, from the middle of May to the first of June.

In short, the bulk of the insects hatch in ordinary seasons about the middle of March in latitude 35°, and continue to hatch most numerously about four days later with each degree of latitude north, until along the forty-ninth parallel the same scenes are repeated that occurred in Southern Texas seven or eight weeks before.

From a number of experiments which we have made on the eggs we conclude that, with a constant temperature of 85° F., with favorable conditions of soil, the eggs will hatch in from four to five weeks after they are laid, and in a temperature of 75° F. in about six weeks. Mr. Riley has had the eggs of *Caloptenus atlanis* (laid in July) hatched in from three to four weeks; those of *Dragocephala viridifasciata* (laid in June) in three weeks; and those of *Acridium Americanum* (laid in July) in rather more than a month.

HABITS OF THE YOUNG OR UNFLEDGED LOCUSTS IN THE TEMPORARY REGION.

"The habits of the young insects as they occur in the temporary region, and particularly in the country south of the forty-fourth parallel and east of the one hundredth meridian, are as follows: Although possessed

of remarkably active powers from the moment they leave the egg, yet so long as provision suffices for them on their hatching-grounds the young remain almost stationary and create but little apprehension. As soon, however, as the supply of food in these situations is exhausted, they commence to migrate, frequently in a body a mile wide, devouring, as they advance, all the grass, grain, and garden-truck in their path. The migrating propensity is not developed until after the first molt, and often not till after the second or third. Up to that time they are content to huddle in warm places, and live, for the most part, on weeds, and especially on the common Dog-fennel or May-weed (*Maruta*) where it is present.

"The young locusts display gregarious instincts from the start, and congregate in immense numbers in warm and sunny places. They thus often blacken the sides of houses or the sides of hills. They remain thus huddled together during cold, damp weather. When not traveling, and when food is abundant, or during bad, rainy weather, they are fond of congregating on fences, buildings, trees, or anything removed from the moist ground. They also prefer to get into such positions to undergo their different molts. In fields they collect at night or during cold, damp weather, under any rubbish that may be at hand, and may be enticed under straw, hay, &c., scattered on the ground. Old prairie-grass affords good shelter, and where a wheat-field is surrounded with unburned prairie, they will gather for shelter along the borders of this last."

It is more particularly while they are yet small, or in what are described in Chapter X as the first, second, and third stages, that the young locusts hide at night, and, during unfavorable weather, at day also. In windy weather they are fond of gathering and secreting under any shelter, or in crevices and inequalities of the soil. At such times farmers too often conclude that the pests have perished and vanished; but a few hours of pleasant, sunny weather will bring the insects to sight again and dispel the delusion. When very vigorous and numerous they gradually move across a field of small grain and cut it off clean to the ground as they go, appearing to constantly feed. But when diseased or sickly, as in 1877, they gather in bare and sunny spots and huddle and bask without feeding. The very cold, wet weather that is prejudicial to them is beneficial to the grain, and under such circumstances it generally grows so rank and rapidly that they make little impression upon it.

It is when they are abundant and vigorous enough to bare the ground of vegetation, and this principally after they are half-grown, that the habit of migrating in large bodies is developed. In 1877 scarcely any disposition to migrate was shown, and this was in strong contrast with what occurred in 1875. In a year like this last, when they are vigorous and abundant, their power for injury increases with their growth. "At first devouring the vegetation in particular fields and patches in the vicinity of their birthplaces, they gradually widen the area of their

devastation, until at last, if very numerous, they devour every green thing over extensive districts. Whenever they have thus devasted a country they are forced to feed upon one another, and perish in immense numbers from debility and starvation. Whenever timber is accessible they collect in it, and after cleaning out the underbrush, feed upon the dead leaves and bark. A few succeed in climbing up into the rougher-barked trees, where they feed upon the foliage, and it is amusing to see with what avidity the famished individuals below scramble for any fallen leaf that the more fortunate mounted ones may chance to sever. This increase in destructiveness continues until the bulk of the locusts have undergone their larval molts and attained the pupa state. The pupa, being brighter colored, with more orange than the larva, the insects now look, as they congregate, like swarms of bees. From this time on they begin to decrease in numbers, though retaining their ravenous propensities. They die rapidly from disease and from the attacks of natural enemies, while a large number fall a prey, while in the helpless condition of molting, to the cannibalistic proclivities of their own kind. Those that acquire wings rise in the air during the warmer parts of the day, and wend their way as far as the wind will permit toward their native home in the Northwest. They mostly carry with them the germs of disease or are parasitized, and wherever they settle do comparatively little damage."

DIRECTIONS IN WHICH THE YOUNG LOCUSTS TRAVEL.

The young insects when migrating move, as a rule, during the warmer hours of the day only, feeding, if hungry, by the way, but generally marching in a given direction until toward evening. They travel in schools or armies, to no particular or constant point of the compass, but purely in search of food—the same school one day often pursuing a different course from that pursued the day previous. On this point the experience of 1875 as well as of 1877 is conclusive, though the bulk of the testimony as to their actions, when hatching out in the more northern States, is to the effect that the prevailing direction taken is south or southeast, while in Southern Texas it is just opposite, or north. A person traveling along a road may often see one army marching in one direction to the left and another in the opposite direction to the right, and we have repeatedly had such an experience.

If, from any reason whatsoever, the vanguard of a column changes its course, the changed direction is in some way communicated in wave-like form to those in the rear. Usually, the front of a column is not easily diverted, however, but will pass through such obstacles as open fences rather than change course. Sometimes two schools going in different directions will cross each other, the individuals of either keeping to their particular course and presenting a singular spectacle as they hop past one another.

It is recorded in Europe that few things, not even water, stop the

armies of the young locusts when on the march, and Döngingk relates having seen them swim over the Dnjestr for a stretch of 1¼ German miles, and in layers 7 or 8 inches thick.[36] We have had similar experience with our own species. In 1875, near Lane, Kans., they crossed the Potawotomie Creek, which is about four rods wide, by millions; while the Big and Little Blues, tributaries of the Missouri, near Independence, the one about 100 feet wide at its mouth, and the other not so wide, were crossed at numerous places by the moving armies, which would march down to the water's edge and commence jumping in, one upon another, till they would ponton the stream, so as to effect a crossing. Two of these mighty armies also met, one moving east and the other west, on the river-bluff, in the same locality, and each turning their course north and down the bluff, and coming to a perpendicular ledge of rock 25 or 30 feet high, passed over in a sheet apparently 6 or 7 inches thick, and causing a roaring noise similar to a cataract of water. (Riley's Eighth Report, p. 118.)

The experience of correspondents as to the movements of the young (App. 15) is very conflicting, as it naturally would be from what we have already said. One man will notice the insects moving with the wind, and conclude that it is the rule for them to do so; another, against the wind, and draw an opposite conclusion.

RATE AT WHICH THE YOUNG TRAVEL.

"When about half-grown they seldom move at a greater rate than three yards a minute, even when at their greatest speed over a tolerably smooth and level road, and not halting to feed. They walk three-fourths this distance and hop the rest. Two consecutive hops are seldom taken, and any individual one may be run down and fatigued by obliging it to hop ten or twelve times without a rest."

According to Sydow, the young of the European *migratoria* travel, when at their most rapid gait, a German mile in four hours. Even taking the shortest German mile, or nearly four English miles, we very much doubt the accuracy of this statement, for though the *migratoria* is a larger species than *spretus*, we cannot believe that it travels nearly ten times as fast, and we have again and again timed our own species.

THEY REACH, IN THE TEMPORARY REGION, BUT A FEW MILES EAST OF WHERE THEY HATCH.

"At the rate at which they travel, as just described, they could not extend many miles, even if they continued to travel in one direction from the time of hatching until maturity. They travel, on an average, not more than 6 hours per day; and their unfledged existence terminates in from 6 to 8, say 7 weeks. It is very easy to calculate from these facts that if they continued in one direction from the time they hatch until they acquire wings, they could not extend 30 miles. In reality,

[36] Köppen *loc. cit.*, p. 43.

however, they do not travel every day; and where food is abundant they scarcely travel at all."

Moreover, as we have just shown, the migratory propensity is seldom manifested during the first or second larval stages, and it is, in fact, largely dependent on conditions of health and vigor of the insects, and on the amount of food supply. We have learned of no cases where the young have extended, during growth, ten miles east of the hatching limit.

As we shall presently show—and the fact is more fully brought out in Chapter VI—the insects, when they get wings in the Temporary region, especially in early summer, instinctively fly to the north or northwest, and do not extend to do damage farther east. Those, also, which acquire wings later in the summer in more northerly regions, and which fly more to the south, never extend any great distance east of where they hatch; those developing on the eastern confines of the species' range (Map I), passing southwestwardly, and those born toward the mountains southeastwardly. In 1875, a few stragglers were carried as far as the center of Missouri by being swept into the Missouri River, and drifting on logs and chips during the annual rise in July. But whenever scattering individuals are carried in this or any other way beyond the eastern limits we have laid down, they soon perish. Most of them are diseased or disabled, and if they lay eggs, these hatch in the autumn and perish at the approach of winter.

NOT LED BY "KINGS" OR "QUEENS."

"The idea that the young locusts are led in their marches by so-called 'kings' or 'queens' has been at different times very prevelent. It is, however, quite unfounded. Certain large locusts, belonging to the genera *Acridium* and *Œdipoda*, hibernate in the full-grown, winged state, and not in the egg state, like the Rocky Mountain species. Always with us, their presence is simply more manifest in the spring, when the face of the earth is bare. Hopping with the others or falling into ditches with them, they give rise to this false notion, and it is an interesting fact, as showing how the same circumstances at times give rise to similar erroneous ideas in widely separate parts of the world, that the same idea prevails in parts of Europe and Asia.

FIG. 6.—AMERICAN ACRIDIUM. (After Riley.)

"The two species which are most often thus found with the young locusts, and supposed from their size and conspicuousness to be guides, are the American Acridium (*Acridium Americanum* Drury, Fig. 6), and the Coral-winged Locust (*Œdipoda phœnicoptera* Germ., Fig. 7). The former is our largest and most elegant locust, the prevailing color being dark brown, with a broad, pale-yellowish line along the middle of the back when the wings are closed. The rest of the body is marked with deep brown, verging to black, with pale reddish-brown, and with whitish or greenish yellow; the front wings being prettily mottled, the hind wings very faintly greenish, with brown veins, and the hind shanks generally coral-red with black-tipped, white spines. The species is quite variable in color, size, and marks, and several of the varieties have been described as distinct species. The coral-winged locust is also an elegant species, the colors being brown-black, brick-yellow inclining to brown, and a still paler, whitish gray; the hind wings varying from vermilion-red to pink, with more or less yellowish-green, and with a broad external dusky border, broadest and palest at tip. The hind shanks are yellow, with black-tipped spines. This species is also quite variable."

Fig. 7.—Coral-winged Locust. (After Riley.)

TIME OF YEAR WHEN WINGS ARE ACQUIRED.

The time elapsing between birth and the acquirement of full wings varies according to season and weather; cold, wet weather retarding, warm, dry weather accelerating development. At Saint Louis, in an inclosure outdoors, we have obtained the mature insect in 72 days from hatching, and the first pupal or fourth stage in 29 days from hatching, indoors. Mr. Whitman, from a single experiment made in 1877, found that exactly 60 days elapsed from birth to maturity, in confinement. In Southern Texas, in 1877, the locusts began to fly by the middle of April; from South Iowa northward, from the middle of May to the middle of July. The average period, at Saint Louis, between hatching and maturity, of *C. femur-rubrum*, we have found to be 70 days; of *C. atlanis*, 80 days; of *Acridium Americanum*, 70 days. In 1875, when the hatching and development of *spretus* were more regular and normal than in 1877, the interval was from 42 to 60 days, and we may put the average interval, under favorable conditions, at 50 days. By adding these 50 days to the time given (*ante*, p. —), when the bulk of the insects hatch in different latitudes, we get the time of year when the great body of them will acquire wings, and by allowing 5 days more for the migrating propensity to become fully developed, we can calculate, within a few days, the time when the winged insects will be most numerously leaving any part of

the temporary region, viz, from the 5th to the 10th of May, in latitude 35°, and about 4 days later with each degree farther north.

DIRECTION TAKEN BY SWARMS DEPARTING FROM THE TEMPORARY REGION.

While the swarms that invade the fertile parts of the West in late summer and autumn move, as we have just seen (p. —), conspicuously to the south and southeast, the departing swarms in early summer from the temporary region move as conspicuously to the north and northwest. In short, as we have set forth in Chapter VII, there is a return migration toward the breeding-grounds of the immediate parents.

In the more western and northern parts of the locust region, east of the mountains, as in Minnesota, Dakota, and Colorado, the direction of the departing swarms will be less constant, and according as they develop late, or are the progeny of swarms that came from other directions than the northwest, they will either be carried by the wind or will instinctively leave in other directions.

DESTINATION OF THE DEPARTING SWARMS.

What eventually becomes of the insects which thus wend their way on the wing toward the northwest in early summer? Whither do they go? These are questions constantly asked by people in the locust region. The history of the return flights of 1875 shows conclusively that those insects which were healthy and vigorous enough to sustain long flight, reached what we have termed the permanent breeding-grounds. The records as given in Mr. Riley's Eighth Report clearly prove that they reached into Northwest Dakota, Wyoming, and Montana, and the following passage from an article by Prof. G. M. Dawson in the Canadian Naturalist, on the movements of locusts that year, gives the points which they reached north of the boundary line:

> Foreign swarms from the south crossed the 49th parallel with a wide front stretching from the 98th to the 108th meridian, and are quite distinguishable from those produced in the country, from the fact that many of them arrived before the latter were mature. These flights constituted the extreme northern part of the army returning northward and northwestward from the States ravaged in the autumn of 1874. They appeared at Fort Ellice on the 13th of June, and at Qu'Appelle Fort on the 17th of the same month, favored much, no doubt, by the steady south and southeast winds, which, according to the meteorological register at Winnipeg, prevailed on the 12th of June and for about a week thereafter. After their first appearance, however, their subsequent progress seems to have been comparatively slow, and their advancing border very irregular in outline. They are said to have reached Swan Lake House—the most northerly point to which they are known to have attained—about July 10; while Fort Pelly, farther west, and nearly a degree farther south, was reached July 20th, and about seven days were occupied in the journey from there to Swan River Barracks, a distance of only ten miles.

In 1877, as is shown in Chapter VII, the northward flight seems to have been less persistent toward the boundary line, and while there is

reason to believe that some of the insects reached as far as the North Saskatchewan, the movement was by no means so constant nor so general as in 1875.[37]

The locusts which reach beyond the 50th parallel by the middle of June must needs have developed many degrees south, and even were there not actual observations to prove it, such facts strongly indicate the destination of the swarms from the more southern country to be the Northwest.

The insects which leave the Temporary region are always greatly infested by parasites, and are constantly dropping and perishing on their northward course, a fact established by our own personal observations as well as by general experience. Many of them also perish, just as do the young, from disease and the effects of storms. We may very justly conclude, therefore, that a large proportion of the insects which depart from the Temporary region perish on their way toward the native breeding-grounds of the species, and that those which do not so perish reach the high plains regions of the Northwest, whence their parents had come the previous year. "They are carried back with favoring winds, in thinned and weakened ranks, and those that did not start with the germs of disease, and which escape from other vicissitudes, doubtless succeed in reaching those conditions which favor the continued perpetuation of the species. They do comparatively little harm on the way, and are not, by any manner of means, to be likened to the more disastrous swarms from the opposite direction in the fall."

The return movement is mostly over the thinly-settled plains regions, and the diseased and debilitated insects may drop and die by myriads in such country without being observed, and we may rest assured that this is one way in which they vanish; that this is, in fact, the destination of a very large proportion of the returning insects.

DO THE RETURN SWARMS BREED?

It is quite important for us to know whether the insects that hatch in the Temporary region continue to breed when they get to the Permanent region; because, if the permanent breeding-grounds are recruited from the insects which hatch and develop to the southeast, there is all the greater incentive for our farmers to destroy the young insects. The more effectually these are destroyed, the less frequent in this event will be the invasions from the northwest. From the facts at hand there can be no doubt that a portion of the returning locusts do thus breed, and it is our opinion that the propagation of the species is the prime object of the northward flights. It is doubtful, however, whether the issue

[37] The Detroit Record published last fall a statement made to Mr. W. J. Wheeler of that town, to the effect that the "Lake of the Woods" was "covered with dead grasshoppers, and all along the southeast shore the dead 'hoppers were over two feet thick." There is nothing improbable in this report, which would indicate that the eastward wing of the northward flights largely perished in that way; but we have been unable to get corroboration of the fact, and Mr. L. R. Bentley, of Saint Frances, who was on the Wood and Rainy Rivers from June, saw nothing of the sort.

survives to propagate when hatching out the same season, or whether any but those which reach sufficiently northern latitudes to insure the keeping of the eggs through the winter, are instrumental in perpetuating the species.

In a year like 1875, when vast and heavy swarms succeed in reaching the Permanent region, they no doubt lay eggs, and their issue the following year is very apt to invade the fertile country again, especially if, as was the case in 1876, they are joined by others whose parents had hatched the previous year in said Permanent region. In a year like 1877 (and that of 1867 was very similar), comparatively few of the departing insects got back to breed, the great bulk of them perishing on the way.

DO DEPARTING SWARMS FROM THE TEMPORARY REGION EVER RETRACE THEIR COURSE?

This is a question more difficult to answer, but which must be answered, from present knowledge, in the negative at least for those which depart from south of the 42d parallel. A few scattering individuals were observed passing southward in Missouri, Kansas, and Texas, in the autumn of 1875, and while their small size and dark color indicated that they had not come from the far northwest, the lateness of the season precluded their being the same individuals which in early summer had flown from the same States. There are, in fact, good reasons why all those which breed south of latitude 42° should not return after once leaving the country in which they hatch.[37a] Those of them which do not perish will have laid their eggs before the winds set in to the southeast, and should they return to oviposit where they developed the eggs would prematurely hatch and the second generation of young perish. This reasoning applies with less and less force as we go north and west, or, in other words, as we approach the permanent region, and the probability is that in what we have termed the Subpermanent region many of the insects which depart toward the north, subsequently retrace their course. The records seem to indicate that such was the case in 1877, and the autumn flights which we have reported (App. 12) were, in all probability, composed of insects reared in said subpermanent country; for they were neither as disastrous, as injurious, nor as fecund as those which in previous years have come from the farther northwest.

THE SPECIES IS ESSENTIALLY SINGLE-BROODED.

Some writers, and notably Mr. G. M. Dodge, of Glencoe, Dodge County, Nebraska, have strenuously advocated the belief that the Rocky Mountain locust produces two generations annually, and as it is our desire to get at the facts in such a case, since they have an important bearing on the general problem, we present Mr. Dodge's arguments as the strongest that can be made in favor of such a view; for he has had

[37a] Mr. Thomas dissents from this conclusion, believing that swarms often retrace their course, even when departing from S. of the 42d parallel.

much experience, and his opinion deserves consideration. The question can also be best discussed in reply to such an argument:

GLENCOE, DODGE COUNTY, NEBRASKA,
October 18, 1877.

DEAR SIR: I have frequently taken occasion to express, through the medium of various publications, my belief in the double-brooded character of the Rocky Mountain locust, and during several years' experience with this insect I have seen no good reason for changing my opinion.

It is an undisputed fact that instinct in insects is chiefly displayed in providing for the reproduction of the species. Why should this not be the case with our locust? It is plain that the locust is guided by instinct in its migrations, from the following facts, which I can substantiate by my own notes and those of other observers.

1. The migrating locust always leaves its breeding-grounds as soon as it has gained sufficient strength to take long flights, providing it is not delayed by storms or contrary winds. That this movement is not made on account of hunger is shown by the fact that it passes over large tracts of luxuriant vegetation without alighting, and when obliged to stop for rest or food, immediately resumes its flight if wind and weather continue favorable. An instance is seen in the conduct of those hatched in Missouri in 1875, which flew away to the northwest, leaving almost untouched the growing crops of the border States.

2. They fly north in the first part of the season, and south in the latter part, and no amount of adverse weather can turn them back on their course.

When flying north they go indifferently with a southeast or southwest wind, and *vice versa* when flying south; but a head wind always brings them down, and however great their apparent anxiety to move on, they invariably wait for a wind that will bear them upon the same general course that they first took. A distinction must here be made between their flight when migrating and their movements in search of food. During the latter, they fly near the ground to any point of the compass, frequently making a simultaneous movement over large areas. But this is not migrating, although it undoubtedly occasions many of the conflicting reports that annually appear in regard to their course of travel. The habit of waiting for a favorable wind must have been observed by all who have seen the locust on its travels, and it shows that its course of migration is governed by fixed rules, wholly independent of the prevailing winds, except as they may serve to bear it toward the desired point.

Taking any given year, I find that winged locusts begin to arrive here in May (in one instance as early as May 12) and continue to pass over from the south until the middle or latter part of July. They begin arriving from the north sometimes as early as July 1, and continue to fly over at intervals until late in autumn.

In 1873, one of these southern swarms, being compelled to alight here by rainy weather in May, deposited many eggs, which hatched in June of the same season. The young became full-fledged and flew south about the middle of August. It is evident that the parent swarm was hatched that spring in the north; and the fact that a second brood was produced from their eggs that season shows that the species is double-brooded under favorable conditions. Such conditions are obtained by the habit of migrating from a southern to a northern climate.

If the swarm that halted here had continued its flight with favorable weather hundreds of miles farther north, the second brood would have been produced just the same.

Every year, as all observers know, immense swarms go north in the spring, and I do not doubt that their progeny, reared upon the tender pasturage of the north, constitute the swarms that annually move south in the late summer and fall.

Probably the annual migratory movements are performed upon the plains with more regularity than in the Mississippi Valley, where storms and changeable winds serve to impede their progress. It may not be possible for this species to invariably mature two broods in one season, and in that case nature may have provided for the preservation

of the eggs over winter. Many insects that are double-brooded in the south are single-brooded farther north. But I regard the attempt to produce a second brood as the only motive for locust migrations.

If I am correct, there is nothing easier, as I have frequently suggested, than to predict the course of these migrations and, by means of signal-stations, to advise the farming community, months beforehand, of the direction from which swarms may be expected to come and the time of year when such flights will occur.

Thanking you for your courtesy in offering me this opportunity of bringing my views before the public in a permannet form, I remain,

Yours, very truly,

G. M. DODGE.

Prof. C. V. RILEY.

We concur with all that Mr. Dodge says regarding the migratory movements, but the force of the argument in favor of double-broodedness depends on the facts stated regarding the occurrences in 1873. Knowing that the evidence is overwhelmingly in favor of normal single-broodedness, but feeling that the rule did not preclude exceptions, we appealed to Mr. Dodge for reasons for the confident statement that the young which hatched in June, 1873, were from the eggs laid in May, and not from eggs laid the previous autumn, since hatching, in that latitude, from eggs laid the previous fall, is often delayed from one cause and another till into June. Mr. Dodge replied that he did not make the observations himself, not having moved to Nebraska till August of that year, but that he was in correspondence at the time with an intelligent person, from whom he obtained the information. We have, therefore, no absolute and positive evidence that the young locusts observed in June were from the eggs laid in May. Supposing, however, that they were, there is still no evidence that the second generation became fledged and flew south in August, because the winged insect which Mr. Dodge found there when he arrived may have come from some other source, since, as will be seen in Chapter II, there was a pretty general invasion from the northwest in the autumn of that year over parts of Colorado, Wyoming, Dakota, Nebraska, and Iowa.[38]

That a second generation may exceptionally be produced the same season in the Subpermanent region from eggs laid by insects that developed farther south, we have no doubt whatever; for we found a small proportion of the return insects that were flying over Nebo, Nebr., on the 23d of June, last year, to contain well-developed eggs; and, aside from Mr. Dodge's conclusions, Mr. Whitman informs us that in a letter received from Mr. W. H. Woods, of O'Brien, O'Brien County, Iowa, the locusts are reported to have come there, in 1873, in comparatively few numbers from the south and southwest. They came June 4, and depos-

[38] An additional fact may be recorded here. In the fall of 1873, after the insects had passed from the north over half of Emmett County, Iowa, Mr. E. B. Soper, of Easterville, writes: "The wind changed and blew for six days from the south. The insects refusing to be carried back, kept to the ground and laid many eggs."

ited eggs and left June 7. On July 8, the young hatched and were thick, but *they did but little damage, and soon left, no one knew whither.* We have a similar statement from Professor Aughey. In 1865, the insects which hatched in Dakota County, Northeastern Nebraska, did not leave. They laid eggs which hatched the same season, and *the young all perished.*

We have also most conclusive evidence from Mr. E. B. Soper, of Esterville, Emmett County, Iowa, of the second brood in 1873 coming to naught. His account, as that of a resident, has weight, and accords with history. He writes us that the locusts came from the southwest in June, about the 23d; they did much damage; laid in July, scattered and passed on, some, however, remaining. Many of the young hatched through the autumn and perished, but the bulk of them did not hatch till the spring of 1874, from the last of April to the middle of May, when the greatest damage was done. Mr. G. F. Blanchard, of Fremont, Nebr., (App. 8), also records the insects that came there from Texas in June, 1873, as laying eggs. The eggs hatched, but no further account is given of the young.

While, therefore, we admit the possibility of a second generation, we believe that it is exceptional, and that the insects composing such second generation seldom, if ever, attain maturity or perpetuate their kind. That the species is essentially single-brooded, will appear from the following generalizations:

1st. It is sub-boreal in range and comes to perfection only where the winters are long and severe and the summers short.

2d. In years of disastrous invasion from the northwest, in late summer and autumn, the insects have not prevailed to the south during the spring.

3d. In years when the insects hatch and prevail in the Temporary region, the exodus therefrom in early summer is virtually complete, and there are no disastrous incoming swarms into the same region later in the season.

4th. Where the species has been observed to breed, as in Minnesota and northerly regions, for two or three consecutive years, but one annual generation is produced.

5th. The insects which reach Manitoba in June and July from the south lay, but the bulk of the eggs remain unhatched till the following spring. The same holds true in Minnesota, for the records show that the eggs laid in June and July, 1873, mostly remained unhatched till 1874.

Single-broodedness is, then, the rule. Like all rules, it has its exceptions. Many insects that are monogoneutic in northerly latitudes become digoneutic farther south; yet most of the locusts that we have studied, are monogoneutic even in the latitude of Saint Louis. *Caloptenus atlanis*, the nearest allied to *spretus*, is one of the exceptions, for we have proved it to be double-brooded. This fact indicates that if

spretus could establish itself under similar climatic influences, it would also be digoneutic, and the premature hatching of its eggs in autumn, when laid in southerly regions, is nothing but a step toward digoneutism. But the record shows that it cannot so establish itself, and that it can breed permanently under those conditions only which induce single-broodedness.

THE SPECIES CANNOT PERMANENTLY DWELL IN THE TEMPORARY REGION.

Intimately connected with the question we have just considered, is the consideration of the present statement. That the disastrous invasions into the Mississippi Valley, like those of 1866, 1874, and 1876, have their source in what we designate as the Permanent region, is abundantly proven from what has preceded in Chapters II and V. It is matter of common observation that the insects that participate in such invasions are longer-winged and paler than those which develop in the Temporary region, and this fact accords with the records, in placing their origin in the high dry plains regions of the Northwest; for naturalists find it to be a very general rule that paleness of color and increase of size and of wing-power are characteristic of animals inhabiting the said region.

The comparatively sudden change from the attenuated and dry atmosphere of the elevated plains and plateaus which constitute the Permanent region to the more humid and low prairie region of the Mississippi Valley proper, is injurious to the species, though its consequences are not manifest with the invading insects, except, perhaps, in limiting their eastward progress. The first generation, however, hatched in the low, alluvial country, is more or less unhealthy, and the insects do not breed here, but quit the country and get back, as far as they are able, to more congenial breeding-grounds. If the weather be particularly wet and cold they perish in immense numbers, and there is every reason to believe that even the bulk of those which attain maturity are intestate and perish without procreating, because the large majority of those which drop on the return to the Northwest contain no eggs. In the Subpermanent region, or as we go west and northwest, the species propagates, and becomes localized more and more until we reach the country where it is always found. Nothing is more certain than that the species is not autochthonous in Texas, West Arkansas, Indian Territory, West Missouri, Kansas, Western Iowa, Nebraska, or even Minnesota; and whenever it overruns any of those States, it sooner or later abandons them.

"We may perhaps find, in addition to the comparatively sudden change from an attenuated and dry to a more dense and humid atmosphere, another tangible barrier to the insect's permanent multiplication in the more fertile country to the southeast, in the lengthened summer season. As with annual plants, so with insects (like this locust) which pro-

duce but one generation annually and whose active existence is bounded by the spring and autumn frosts, the duration of active life is proportioned to the length of the growing season."

Hatching late and coming to maturity in July and August, in its native haunts, the species, when born in the southeast country, is in the condition of a subalpine or boreal annual plant grown in a southern climate. Such a plant will rarely hold its own in the changed climate. If it lives at all, it grows more rankly, blossoms prematurely, and deteriorates. For want of the proper ripening influence of autumn, the seeds either fail to mature, or, if they mature, they germinate out of season, and the plant perishes in the second generation. Our locust must and does deteriorate under the same circumstances, and the power of migrating back to a congenial climate alone saves it from perishing.

Had the insects which hatched in Texas, Missouri, Kansas, &c., in 1875 or 1877 remained there to propagate, their eggs would all have prematurely hatched the same season: the young would have been still more feeble than their parents which hatched in spring, and would most of them have perished before they had had time to procreate and provide for the continuance of the species. It has often occurred to us that the species might, in the Temporary region, become profoundly modified in the course of two or three generations in the direction of *atlanis;* and that in this way and through miscegenation with allied indigenous species its extinction from said region might to some extent be accounted for; but the evidence is against this supposition, and such influences play a very unimportant part, if any, and should not be considered factors in the problem. All that can leave do so, and those which do not, eventually perish. The fact of deterioration, debility, and disease in our Rocky Mountain locust when in the southeast country is very generally recognized by farmers, while all close observers recognize it. The following opinions of well-known naturalists in the locust region may go on record in this connection:

Mr. Riley is of the opinion that the grasshoppers run out in a few generations after they leave their native sandy and gravelly soil. My experiments, so far as they go, verify that opinion. For several years I have caught grasshoppers during early summer that came fresh from the direction of the mountains, and by attaching their legs with fine silk threads to a small spring-balance, found that their physical strength was twenty-five to fifty per cent. greater than that of grasshoppers treated the same way that were hatched in Nebraska or in States farther eastward or northward. The same result was reached by caging them and ascertaining how long they would live without food and also by vivisection. In some places, also, the eggs that were laid in different years since 1864 did not hatch out. The changes from extreme wet to dry and from cold to hot weather, or some other unknown causes, seem to sap their constitutional vigor. Were it not for this, long ere now these grasshoppers would, from their enormous numbers, have desolated the whole country as far east as the Atlantic.—(Prof. Samuel Aughey, of the University of Nebraska, in the Lincoln (Nebr.) Journal.)

I have observed hundreds of winged locusts fall to the ground during flight, either already dead or soon dying. These, upon examination, have generally proved to con-

tain no parasites, and I judge that their death was in consequence of impaired strength, this second generation, raised in an unnatural climate, not equaling in vitality the first generation, and succumbing to the fatigue consequent upon extended flight.—(Prof. F. H. Snow, of Kansas State University, in Observer of Nature.)

Anxious not to let the occasion pass without fully testing the ability of the species to sustain itself and multiply in the Lower Mississippi Valley country, we made experiments the past summer both at Saint Louis, Mo., and Carbondale, Ill. At the former station, aside from the indoor experiments alluded to in discussing the breeding habits of the species, and in which we hatched many thousands of eggs from Kansas, and vainly endeavored to bring the insects to maturity in spacious vivaria, we also conducted an extensive experiment in the open air. We built a tight inclosure, 12 by 12 feet square and 3½ feet high, and so lined with sloping zinc around the edges that no unfledged locust could escape. There was plenty of grass and weeds in the inclosure, and we hatched therein many thousands of young *spreti*. The inclosure was watched carefully. Most of the insects died in the second and third stages, and one solitary female, small, feeble, and with colorless hind thighs, acquired full wings, but died soon after being brought indoors. At Carbondale the experiment, in cages, and with eggs from Minnesota, was more successful. A number of the specimens became winged, and some lived till the latter part of September, but laid no eggs.

DO THE INSECTS WHICH HATCH IN THE TEMPORARY REGION EVER REMAIN, AND, IF SO, DO THEY LAY EGGS?

The exodus of the winged insects from those portions of the Temporary region so sorely ravaged in the spring of 1875 was so complete, that by August, with scarcely an exception, none were to be found south of the 42d parallel. Those which remained were loaded with parasites and soon died. The question whether any of the insects remain in the country indicated, and whether, if so, they lay eggs, is interesting and important. With a view of getting at the facts for 1877, as well as of forming a correct judgment of the prospects for 1878, Mr. Riley sent out the following circular question to his correspondents:

Did any of the locusts remain in your locality after the departure of those which hatched and developed with you; and, if so, were any of them noticed to lay eggs?

The replies to this question (App. 14) indicate how very generally the insects left, and how those which failed to do so died from disease and parasites, and laid no eggs. Mr. G. F. Gaumer writes (December 15, 1877) from Lawrence, Kans., as follows:

Early in August I made a trip through the southern counties, via Fort Scott, to Independence, stopping at several points on the route, and returned over the Leavenworth, Lawrence and Galveston Railroad to Lawrence.

Although I repeatedly sought for *C. spretus*, yet I failed to discover any. Not even a diseased or disabled individual was found. Since that time I have received many boxes of specimens from regions where *spretus* hatched in abundance, but in no instance have they ever contained specimens of that insect.

My correspondents in various portions of the State are generally agreed that no migratory locusts remained over the summer. The few who have reported otherwise mistook native species for the true insect.

Mr. Riley went south to Dallas, Tex., and west to Manhattan, Kans., late in the autumn, with a view of making especial observations on this point, and failed to find any specimens of the Rocky Mountain locust remaining, though the Red-legged and Lesser locusts were sufficiently common; the last species quite so in parts of Kansas, and ovipositing. The experience of 1877 corresponds, therefore, with that of 1875, and we may safely conclude that, with scarcely an exception, the insects which hatch in the Temporary region south of the 42d parallel do not remain to lay eggs. So general is the rule, that where the insects are reported as remaining to lay, it may be assumed as highly probable that the Lesser locust has been mistaken for its large congener. The rule holds less true north of the line indicated.

EXTENSIVE AND THICK EGG-LAYING SELDOM OCCURS TWICE CONSECUTIVELY IN THE SAME LOCALITY.

The history of the Rocky Mountain locust indicates that in the Temporary region its eggs are never laid thickly and extensively in the same locality for two consecutive years. Exceptionally, in restricted locations, eggs may thus be laid for two years consecutively, but the second laying is more apt to come to naught, and the issue from it to perish. This rule will hold less true in the Subpermanent region, and probably will not apply at all to the species in its permanent confines, though even there, wherever eggs are so thickly laid that the resulting insects devour all the vegetation where they are born, these must of necessity migrate to procreate.

We shall propound this rule and the probable explanation of it very much in the language in which it was first stated by Mr. Riley before the National Agricultural Congress at its Chicago meeting last autumn:

In mapping out the country in Kansas and Missouri in which eggs had been laid most thickly in 1876, we were struck with the fact that the very counties in which the young insects had been most numerous and disastrous in 1875 were passed by or avoided, and had no eggs of any consequence laid in them in 1876. The fact was all the more obvious because the insects did much damage to Fall-wheat, and laid eggs all around those counties to the north and south and west. From the exhaustive report on the insect in Minnesota, made by Mr. Allen Whitman, it was also very obvious that those portions of that State which had been most thickly supplied with eggs in 1875, and most injured by the young insects in 1876, were the freest from eggs laid by the late swarms of the latter year, notwithstanding counties all around them were thickly supplied. We were at first inclined to look upon these facts as singular coincidences only; but instances have multiplied. A remarkable one has been furnished by Governor A. Morris, of the North-

west Territory. In 1875 the locusts hatched out in immense numbers, and utterly destroyed the crops in the province of Manitoba. Now, in 1876, they were very numerous over all the third prairie steppe of British America, and largely went to make up the autumn swarms that came into our own country that year. Governor Morris started late in July of 1876 from Winnipeg northwest to make a treaty with certain Indians, and during the first five or six days of August he encountered innumerable locust swarms all the way from the forks of the two main trails to Fort Ellice. The wind was blowing strong from the west all the time—just the very direction to carry the insects straight over into Manitoba. The governor watched their movements with the greatest anxiety, fearing that the Province would again be devastated as it had been the previous year. Yet, during all the time he was passing through the immense swarms, they bore doggedly to the south and southeast, either tacking against the wind or keeping to the ground when unable to do so. Nothing was more remarkable than the manner in which they persisted in refusing to be carried into Manitoba. A few were blown over, but did not alight, and the Province seemed miraculously delivered. Mr. Whitman tells us, again, that in settling in 1877 the insects avoided those counties in Minnesota in which they had hatched most numerously and done greatest injury, but selected such as had not suffered for some years past.

We are inclined to believe that there is more than mere coincidence in these occurrences, and will venture to offer what appears to us a plausible explanation of them. In treating of the natural enemies of this locust, we shall presently show that the mature insects are seriously affected by a little six-legged mite, and that the eggs are preyed upon by another and larger eight-legged mite. We have long believed that the former was the young of the latter; but only the present year, by breeding hundreds from the egg to the mature condition, and studying these mites in all their transformations, have we been able to demonstrate the fact. (See Chap. XI.)

The life-history of this little animal, differing so much in its infancy and maturity that naturalists have classed it in two distinct genera, has much belonging to it of purely scientific interest; but how much more interesting does it now become to our Western farmers! Every careful observer knows how generally the locusts, whenever they abound unprecedentedly, are infested with and debilitated by the little red mites under the wings. Let us imagine those mites dropping by dozens from every locust throughout a given region that is being ravaged, each mite lying in wait to presently pounce, in altered form, upon any locust eggs that it can find; and we cease to wonder that *Caloptenus spretus* quits such a country whenever its wings have become strong enough to enable it to do so, or that flying swarms avoid such localities in descending to oviposit. We may wonder at the instinct that guides them, but no more than we must ever wonder at the many to us equally incompre-

hensible instincts which guide most animals in the preservation and perpetuation of their species. Why, one single leaf like this from the book of Nature throws a flood of light on the habit which the locusts display of roosting above ground, and of many of their other doings; and that book is full of just such lessons to those who carefully and intelligently turn and scan its pages.

What is true of the Locust mite and its influence on the movements and doings of the locust is true, though in a less and varying degree, of the other insect enemies mentioned in Chapter XI, for wherever the locust unduly abounds, there its natural enemies also riot in plenty and rapidly multiply.

As the rule we have thus stated is a most encouraging one for the farmers of the Border States, if it can be established, we have endeavored to get the general experience by requesting replies to the question: "Have you ever known the eggs of this Rocky Mountain Locust to be thickly laid for two consecutive years in the same ground or in the same locality?"

The replies to this question, which we have brought together (App. 23), bear out the general statement, for the large majority of the answers are in the negative, and some of the correspondents have lived in the West for 20 and 25 years. No attempt was made to get numerous replies from Colorado and Minnesota, or from the Northwest, because it is well known that the eggs are often laid there for consecutive years. It is equally true, however, that in those sections where the insect may prevail and hold its own for two or more years in succession, it is seldom so numerous as to keep the earth bare of vegetation in midsummer, and whenever it is so numerous even in Minnesota, the rule seems to hold true, according to Mr. Whitman's experience, as already given.

The rule we wish to lay down may, perhaps, be more safely stated thus: *That whenever the young insects abound to such an extent as to keep the earth bare of vegetation in summer (implying thick and extensive egg-laying the previous year), there will be no eggs laid in such devastated regions the same year.* This means that a year of utter locust devastation like that of 1875, in many parts of the West, is pretty sure to be followed by one of perfect immunity from the pests.

CAUSES OF MIGRATION.

Many writers on the migratory locusts of the "Old World" and on our own species have, naturally enough, discussed the causes of migration. We are of the opinion that most authors have erred in endeavoring to ascribe these migratory movements to any single cause, and that several influences play with varying force, and either singly or combinedly. We must also recognize the fact that the influences bearing on migration fall into two distinct categories, viz, *remote* or general, and *immediate* or special. The remote influences are climatic and meteorological,

and have been considered in Chapter VII. It is, therefore, of the immediate causes that we shall speak in this connection. Were we asked to give any single explanation of the phenomenon we should answer, *excessive multiplication;* for this is evidently the immediate cause, and the others here considered are mostly secondary or but consequences of this one. Of these secondary exciting causes we would instance the following as worthy of consideration:

1. *Hunger.*—Whenever food is lacking, whether through the excessive droughts that are not uncommon in the insects' permanent habitat, or through such excessive multiplication of the species that all vegetation is devoured before the life-course of the individual is completed; there must needs be the strongest incentive to migrate. Such we find to be the case, under like circumstances, with many animals normally non-migratory. Hunger, then, may become an incitation to migration, even where there is not excessive increase.

2. *The procreative instinct.*—From extensive observation we are convinced that there is a natural tendency in the species to seek for fresh breeding-grounds away from the location of birth; yet, even were there no instinctive tendency of the kind, we may find a sufficient incentive for movement from one place to another during the season of procreation in the well known salacious habits and ardor of the males. Whenever the insect is very abundant, the females are much annoyed and disturbed during the act of oviposition, as several males will be constantly attending her; and it is more than probable that she is often driven to take wing in consequence.

3. *Increase of and annoyance from natural enemies.*—No one who has witnessed the excessive abundance in which some of these natural enemies of the locust at times prevail, can for a moment doubt that they often prove a valid cause of migration. The Tachina flies, especially, have been known to follow the locusts in dense clouds, and we have seen them so thick in parts of the West that not a locust could rise from the ground without being pursued by several; and there is no escape from their pursuit until the persecuted victim gets high in the air.

4. *Instinctive impulse.*—Though at first we were unwilling to allow any instinctive guidance in the migrating movements, the more we study the question the more we are inclined to consider as a factor in the problem a certain instinctive prompting to that which is best for the preservation of the species. The persistent movement in a given direction notwithstanding adverse winds, so often recorded in this report; the fact that there is a well marked eastern limit line; and the return migration from the Temporary region, are not, to the same extent, susceptible of any other explanation. Hunger, or excessive multiplication, though we grant them to be important causes of the migration from the Permanent region, generally have little to do with this return migration; because, as we have seen, the insects all leave, whether few or many, and they pass over great stretches of luxuriant vegetation, both

wild and cultivated. The uncongenial climate of the Temporary region doubtless prompts the insect to get back to more congenial regions, and we must allow a certain amount of instinctive guidance akin to that possessed by migratory birds.

FOOD-PLANTS.

"The Rocky Mountain Locust may be said to be almost omnivorous. Scarcely anything comes amiss to the ravenous hosts when famished. They will feed upon the dry bark of trees or the dry lint of seasoned fence-planks; and upon dry leaves, paper, cotton and woolen fabrics. They have been seen literally covering the backs of sheep, eating the wool; and whenever one of their own kind is weak or disabled from whatsoever cause, they go for him or her with cannibalistic ferocity, and soon finish the struggling and kicking unfortunate.[39] They do not refuse even dead animals, but have been seen feasting on dead bats and birds. Few things, therefore, come amiss to them. Yet where food is abundant they are fastidious and much prefer acid, bitter, or peppery food to that which is sweet."

It is quite evident, also, from the facts we have collected, that the insects act somewhat differently during different years in this matter of choice of food-plants, for at one time they will be particularly severe on some plants that had been passed by on a previous occasion. While, therefore, experience is often naturally conflicting as to their preferences and dislikes, the following *resumé* of our notes made during the past four years will prove interesting:

"Vegetables and cereals are their main stay. Turnips, rutabagas, carrots, cabbage, kohlrabi, and radishes are all devoured with avidity; beets and potatoes with less relish, though frequently nothing but a few stalk-stubs of the latter are left, and sometimes the tubers in the ground do not escape. Onions they are very partial to, seldom leaving anything but the outer rind. Of leguminous plants the pods are preferred to the leaves, which are often passed by. Cucurbitaceous plants also suffer most in the fruit. In the matter of tobacco their tastes are cultivated, and they seem to relish an old quid or an old cigar more than the green leaf. Tomatoes and sweet potatoes are not touched so long as other food is accessible." Mr. W. D. Donaldson, of Headsville, Tex., reports a case in Limestone County, in that State, where the insects, in 1876, were noticed to fall greedily upon a tobacco-patch of second growth, and where they died soon after eating thereof. Other cases of the injurious effect of tobacco upon them have been reported to us. It is more than probable, however, that the insects would also have been found to die elsewhere with further investigation, and that the death of those in tobacco-patches resulted from other and more natural causes,

[39] Mr. D. T. Ward, of Irving, Kans., even assured us that he hatched three egg-masses in February, 1877, and that the young, which were kept in a bottle, fed upon one another until one of them became winged. Our own experience and experiments forbid belief in the truth of the statement, and we cite it more to show how unreliable statements often become from a tendency to exaggeration.

since late in the autumn they are constantly dying from exhaustion and senility. At all events the evidence is not sufficiently general and uniform as to the hurtful effects of tobacco to permit us to accept it as a demonstrated fact. Horse-radish is rarely touched.

Of cereals, corn is their favorite; if young and tender, every part is devoured to the ground; if older and drier, the stalks are mostly left; the silk is, however, the first part to go. An impression prevails in Colorado that white corn is more proof against the insects than other kinds. All other cereals are to their taste, except sorghum and broom-corn, which are often left untouched.

Speaking of the immunity often enjoyed by sorghum, Mr. Seth H. Kenny, of Morristown, Minn., himself a most successful grower of this crop, writes:

> I have been for eighteen years a grower of sugar-cane. Last fall made over 600 pounds good brown sugar from cane. I received first premium at State fair and the thanks of Chamber of Commerce at Saint Paul, April 2, and this last spring I am happy to say they do not trouble this crop. I have one acre peas; they are full of hoppers; they eat the pigeon-grass, but do not touch the peas; yet they eat the leaves off my small apple-trees; eat one-third acre onions after I had them weeded. They have eaten some strawberry-vines that were newly set this spring.

It has been very generally remarked in Minnesota that the bearded varieties of wheat are less damaged by the winged insects than the smooth varieties, and in 1877 the Red Osakee suffered less than the Fife. Oats and winter-rye more often escape than other small grains. All the tame grasses are devoured with avidity. Wild prairie-grass is relished when young and tender, but usually little injured when mature. Yet cases are on record by travelers in the Northwest, even during the last century, of the wild grass being so effectually mown down by these locusts as to render it difficult to find feed for horses; and Mr. R. M. Probstfield, who has resided at Moorhead, Minn., since 1859, relates that in 1864 the locusts cleaned off the wild grass, and stripped the trees of leaves to such an extent that the timber wore a wintry aspect.

The insects are fond of Buckwheat and Flax, but less fond of the Castor-bean. Indeed, statements have been repeatedly circulated in the agricultural press that this plant is proof against the locust; but they are incorrect and delusive. The plant is not liked, and ordinarily is passed by or merely nibbled at. The flower is more often devoured than any other part, but the whole plant is not unfrequently ruined. There is a general belief that this plant also acts as a poison on the locusts, but we have been unable to obtain any positive evidence of the fact, and the belief probably arose in the same way as that regarding tobacco.

Last summer we met with several instances where Hungarian grass had been sown on wheat land where the wheat had been badly injured; but the grass was so much liked that the locusts never allowed it to come up. The young insects in spring sometimes kill out a blue-grass pasture, but more generally it recovers from their attacks, and wild

grasses always do. "Young corn is eaten down so often and so deeply into the ground that it is frequently destroyed. Potatoes are not killed by being eaten down, and generally make a crop after the insects leave, without replanting. This is especially the case when they are planted deep, and where the vines as they grow are at first kept covered with earth, which they can be with impunity. The blossoms and stems of peas are left after the leaves are stripped, and parsnips sometimes remain untouched."

Next to vegetables and cereals, they relish the leaves of fruit-trees; they strip apple and sweet cherry trees, leaving nothing but the fruit hanging on the bare twigs. The leaves of the peach are generally left untouched, but the flesh of the unripe fruit is eaten to the stone. Pear trees, according to Professor Gale, suffered less in 1874 than any other kind of orchard tree at the experimental farm of the Agricultural College at Manhattan, Kans. The tender bark of twig and branch and trunk of all these trees is gnawed and girdled, and these girdled trees present a sad picture as one passes through the ravaged country during the subsequent winter. Sour cherry, apricot, and plum trees are less affected by them, while ripe fruit is seldom touched. Mr. Donaldson, of Headsville, Tex., gives as a singular fact, that with him the insects did not eat the young peaches on his trees that were on branches leaning below the horizontal. Grape vines generally suffer more from the girdling of the fruit-stem than from defoliation.

Of berries, raspberries seem to be the most exempt, and this is interesting when we reflect that wild raspberries are common in the northwest country. Strawberries and blackberries suffer more, strawberry beds being frequently ruined. Flowering shrubs generally suffer, especially Rose and Lilac.

"Forest and shade trees suffer in different degrees, and some, when young, are not infrequently killed outright. In 1874, Honey-locust, Red-cedar, Box-elder, Osage-orange, Elm, and Oak, were either untouched or but little injured, while the following trees were preferred in the order of their naming: Ash, Willow, Cottonwood, Balm of Gilead, Silver-leaved and Lombardy poplars, Black-ash, Black-locust, Black-walnut, Hickory, Ailanthus, Maple, Sumach, and evergreens." In 1876 it was observed that the Coffee-bean, Beech, and Soft-maple were more particularly untouched. It is generally supposed that evergreens are avoided, but they suffer all the more that they are so much more sensitive to defoliation than deciduous trees. Hemlock, Arbor-vitæ, the pines, and especially the Norway spruce, are often stripped. The Red-cedar more often escapes, and is, for that reason, called *the iron-clad evergreen* by some of our Western nurserymen. The Austrian and Scotch are also less affected than other pines. Our experience in 1877 would indicate that of all trees the blue-ash is most liked, for we found it everywhere badly eaten, even where other trees were untouched.

Of wild, herbaceous plants, Mayweed or Dog-fennel (*Maruta*) is a

favorite, but Smartweed is liked above all. Indeed, the black bindweed (*Polygonum convolvulus*, L.), which is very common in Minnesota, where it is often called wild buckwheat, is so universally preferred by the locusts that some farmers have thought seriously of cultivating it around their fields as a lure, to draw the insects off from the cultivated crops and thus facilitate the killing of the pests. Among the wild plants least liked may be mentioned Cocklebur, Helianthus, and Purslane, but more particularly the milkweeds (*Asclepias*) and the Dogbane (*Apocynum*). An occasional *Salvia trichostemmoides* and *Vernonia novæboracensis* were also left untouched in the general ruin by the young insects in Missouri in 1875. But the plant of all others that is exempt from the attacks of these ravenous creatures is a low, creeping glossy-leaved herb for some time known to botanists as the *Amarantus blitum* and supposed to have been introduced from Europe. Mr. Sereno Watson has, however, lately described it by the name of *A.* (*Pyxidium*) *blitoides*,[40] and it is common and indigenous to the valleys and plains of the interior from Mexico to Northern Nevada. It is fast spreading eastward.

Mr. Riley found this plant unmolested in Missouri "even where the insects were so hard pushed for food that they were feeding on each other and on dead leaves, the bark of trees, lint of fences, &c., and where they were so thick hiding amid its leaves that fifty to a hundred occurred to the square foot."

The dislike these insects show for leguminous plants is well known, and a crop of peas will often succeed where they abound, when all else is ruined. This is the case alike in Texas and British America, for Mr. J. G. Kittson, of Fort Walsh, N. W. T., writes of his experience in 1877: "Peas are the last vegetable the locust will touch. In Swan River the Mounted Police garden had a large patch of peas *in rows*, and only the outer three rows were damaged, and this was only when the insect had attained its full growth and there was nothing else to feed them." Mr. G. M. Dawson has wisely suggested that this dislike may afford an explanation, on Darwinian grounds, of the prevalence of such plants on the Northwestern plains.

To sum up, where the insects are abundant, the prairie-grass, the wild weeds mentioned as disliked, and the leaves of most of the forest-trees generally remain green; but the little Amarantus is the only plant which we have so far found proof against the insects under all circumstances. A marked preference is always shown for plants that are unhealthy or wilted, and a dislike for those in low, wet, or marshy places.

In concluding these notes on the food-habits of locusts, we will briefly refer to a rather prevalent belief that the newly hatched-locusts live for many days on dew. The belief has originated independently in different parts of the world, is mentioned by Anacreon and Hesiod, and perpetuated by later poets. It is doubtless due to the facts that, if the weather be cool, the young insects huddle together and can live for

[40] Proc. Am. Ac. Sc. & Arts, Vol. XII, p. 273.

several days without feeding; that the nibbling and fretting of these young is hardly noticeable; and that, as we have abundantly proved the past summer, these insects are fond of drinking at all stages of growth.

UNNECESSARY ALARM OFTEN CAUSED BY COMPARATIVELY HARMLESS LOCUSTS.

During years of locust trouble the sense of apprehension is always keen; and many harmless species are looked upon with suspicion by those especially who live beyond the limit of the range of the migratory species, and have no personal acquaintance with it. The large, short-winged locust herewith figured is not infrequently supposed to have some connection with the destructive *spretus*. It is the *Brachypeplus magnus* of entomologists, and may be popularly called the Clumsy Locust. It is one of our largest and clumsiest species, incapable of flight, and never doing serious injury. It is common on the plains of Western Kansas and Colorado, and has been found in West Missouri. It is prettily marked, as in Fig. 8, and occurs in two distinct varieties, one in which a bright yellowish-green prevails, and the other in which fleshy tints and pale brown predominate. There can be no connection between its appearance and that of *spretus*.

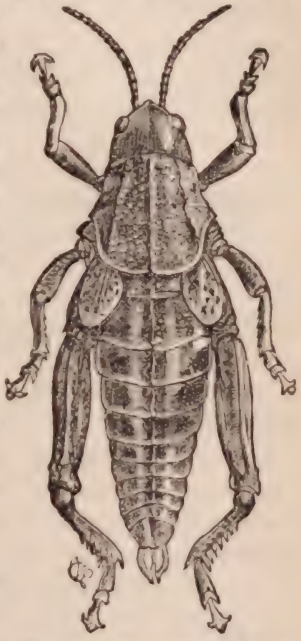

Fig. 8.—The Clumsy Locust. (After Riley.)

Reports are frequent during the mild weather of winter that "the grasshoppers have appeared," and during very mild weather, such as we had in the winter of 1876–'77, the young of the Rocky Mountain locust do sometimes prematurely hatch; but in the great majority of cases the reports of the appearance of this pest in winter are based upon mistaken identity. We have repeatedly had specimens of these young locusts sent to us under the impression by the sender that they were the genuine *spretus*. One of the most common of the locusts which thus give rise to erroneous impressions is the Green-striped locust (*Tragocephala viridifasciata*), a very common species, ranging from Maine to Florida, and from the Atlantic to Nebraska. It passes the winter in the immature condition, sheltering in meadows and in tufts of grass, and becoming active whenever the weather is mild. It is sometimes found in winter in the early larva stages, but more often in the pupa state, and becomes fledged toward the end of April.

"It differs generically from the Rocky Mountain locust, which hibernates in the egg state. This Green-striped locust, as its name implies, has, when mature, a broad green stripe on the front wing, and by its narrower, humped and keeled thorax or fore-body (Fig. 41), may at once

be distinguished from the dreaded Rocky Mountain pest. Like so many other species of its family, it occurs in two well-marked varieties, one in which, in addition to the stripe on the front wings, the whole body and hind thighs, above, are pea-green; the other, in which this color gives way to pale-brown. In both varieties the hind wings are smoky, with the basal third greenish."

FIG. 9.—GREEN-STRIPED LOCUST:—*a*, larva; *b*, perfect insect. (After Riley.)

Different species of the genus *Stenobothrus* are also quite often mistaken for *spretus* in winter and early spring. They are tolerably common in the Western country where *spretus* occurs, and they hibernate in the partly-grown condition. We figure the young and winged form of a species (*S. maculipennis*, Scudd.) that in the unwinged state was quite generally supposed to be the young of *spretus* in Minnesota, last February.

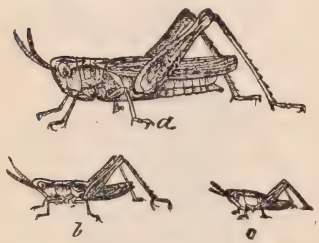

FIG. 10.—STENOBOTHRUS MACULIPENNIS.—*a*, mature insect; *b*, pupa; *c*, larva. (Emerton *del.*)

"The species of the genus *Tettix* also hibernate in the half-grown and sometimes in the full-grown condition, and are frequently supposed to be the young of *spretus*. These insects are very active, and are at once distinguished by the small head, great breadth across the middle of the prothorax, which extends to a tapering point to or beyond the tip of the abdomen; by the front of the breast forming a projection like a stock-cravat, into which to receive the lower part of the head, and by the short, rudimentary, scale-like front wings. They fly with a buzzing noise like a flesh-fly. Our most common species (*Tettix granulata*, Scudder, Fig. 11) may be called the Granulated Grouse-locust. Like the other species, it is very variable in color and ornamentation, the prevailing hue being dark-brown beneath and paler above. A well-marked variety has a small, pale spot on the rudimentary front wings, and a larger conspicuous one on top of the hind thighs."

FIG. 11.—Granulated Grouse-Locust.

Even insects belonging to a different order are not infrequently the cause of unnecessary alarm. In the spring of 1875 the meadows were reported as being destroyed around Champaign and Jacksonville, Ill., by what was supposed to be the young of *spretus*, but which proved upon examination by competent persons to be little Jassoid leaf-hoppers, allied to the common grape-leaf hoppers—insects belonging to a different order (*Hemiptera*) from that which includes the locusts (*Orthoptera*). They were, indeed, *grass-hoppers*, in the sense of hopping about among the grass, but they were not the so-called grasshoppers (locusts)

that at the time were proving such a plague in parts of Kansas and Missouri. In February, 1876, the wheat and oats fields in parts of Texas were being badly damaged by small insects that were similarly supposed to be young locusts, but which, in reality, were also leaf-hoppers; two species, more particularly the *Diedrocephala flavicephala*, Fitch, and a *Jassus* allied to *immicus*, Say, being concerned.

CHAPTER IX.

ANATOMY AND EMBRYOLOGY.

In order to properly understand the habits and physiology of the locust, in connection especially with its great voracity, powers of flight, and the injury it receives from its internal and external parasites—questions of so much importance in studying its natural history and relations to agriculture—it has been thought that a brief general account of its external and internal anatomy, as well as the minute anatomy of the digestive system, would be of considerable practical value.

EXTERNAL ANATOMY.

On making a superficial examination of the locust, any one will soon perceive that its body consists of an external crust, or thick, hard integument, protecting the soft parts or viscera within. This integument will be seen to be at intervals segmented or jointed, the segments more or less like rings, which in turn are subdivided into pieces. These segments or rings are most simple and easily comprehended in the abdomen or hind body, which is composed of 10 of them. The body is composed of 17 of these segments, variously modified and more or less imperfect and difficult to make out, especially at each extremity of the body, namely, in the head and at the end of the abdomen. These 17 segments, moreover, are grouped into 3 regions, 4 composing the head, 3 the thorax, and 10 the hind body, or abdomen. On examining the abdomen, it will be found that the rings are quite perfect, and that each segment may be divided into an upper (tergal), a lateral (pleural), and an under (sternal) portion, or are (Fig. 12, A). These parts are respectively called *tergite*, *pleurite*, and *sternite*, while the upper region of the body is called the *tergum*, the lateral the *pleurum*, and the ventral or under portion the *sternum*.

As these parts are less complicated in the abdomen, we will first describe this region of the body, and then describe the more complex thorax and head. The abdomen is a little over half as long as the body, the tergum extending far down on the side and merging into the pleurum without any suture or seam. The pleurum is indicated by the row of spiracles, which will be noticed further on. The sternum forms the

ventral side of the abdomen, and meets the pleurum on the side of the body.

In the female (Fig. 12, B), the abdomen tapers somewhat toward the end of the body, to which are appended the two pairs of stout, hooked spines, forming the ovipositor (Fig. 12, B *r*, *r'*). The anus is situated above the

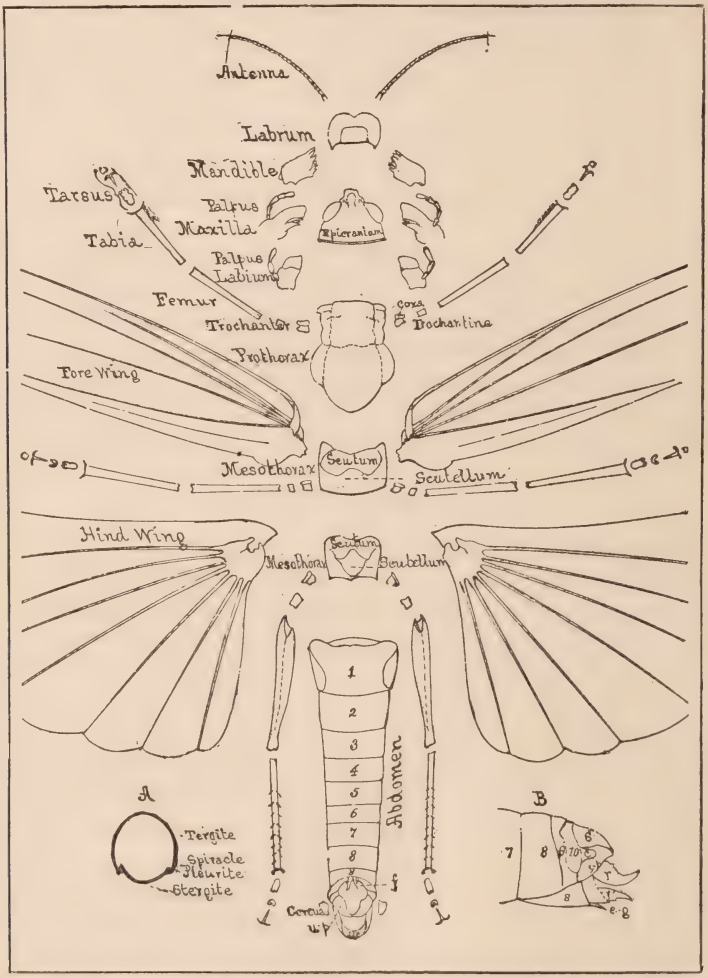

FIG. 12.—EXTERNAL ANATOMY OF CALOPTENUS SPRETUS: the head and thorax disjointed. (Drawn by J. S. Kingsley.)

upper and larger pair, and the external opening of the oviduct, which is situated between the smaller and lower pair of spines, and is bounded on the ventral side by a movable triangular acute flap, the egg-guide (Fig. 12, B *e*, *g*, and Fig. 14). Above the opening of the oviduct and between the two pairs of spines forming the ovipositor is a sharp fork (the *furcula supra-vulvalis*), which is really the third pair of blades of the ovipositor, and well developed in the bee. At the time of egg-laying, the abdomen may be lengthened nearly twice its usual proportions.

The end of the male abdomen is blunt, ending (in our Rocky Mountain species) in a turned-up, notched tip. Immediately in front of the notch is a convex piece or flap, free anteriorly and attached posteriorly and on the sides to the ridge forming the upper edge of the 10th sternite. When about to unite sexually, the tip of the abdomen is depressed, the hood is drawn backward, uncovering the chitinous penis. (This hood may be called *velum penis.*) In front of the hood is the supra anal plate with lateral processes, which may be called infra-anal flaps (or *uro-patagia*, Fig. 12, *up*), concealed by the cerci. At the base of the supra-anal plate, which is broad and shield-shaped, and pointed in front, is the fork or supra-anal furcula (*furcula supra-analis*, Fig. 12, *f*).

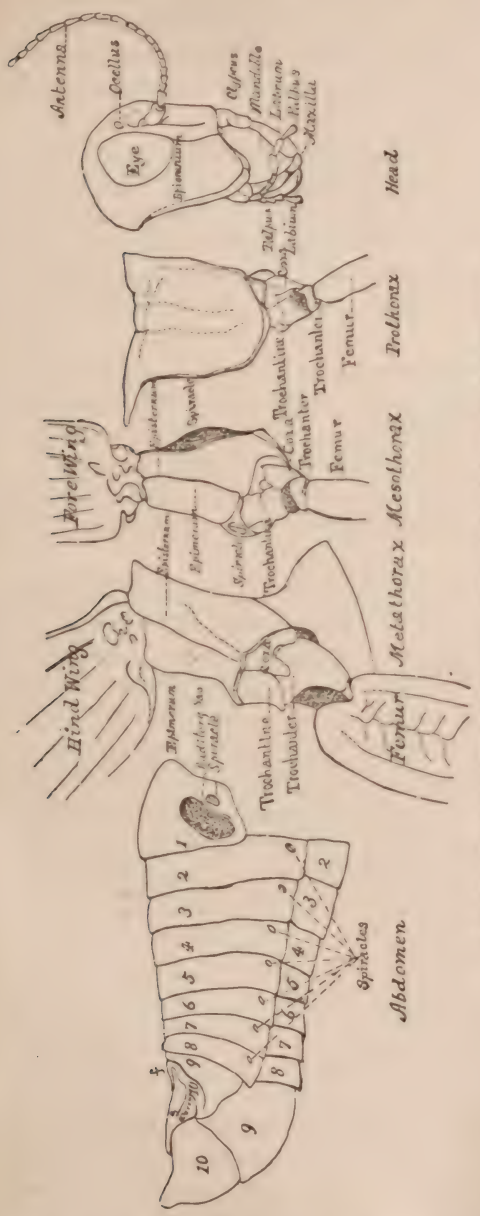

FIG. 13.—MALE CALOPTENUS SPRETUS. (Dissected and drawn by J. S. Kingsley.)

The thorax, as seen in Fig. 12, consists of three segments, called the prothorax, mesothorax, and metathorax, or fore, middle, and hind thoracic rings. They each bear a pair of legs, and the two hinder, each a pair of wings. The upper portion (tergum) of the middle and hind segments, owing to the presence of wings and the necessity of freedom of movement to the muscles of flight, are divided or differentiated into two pieces, the *scutum* and *scutellum*[41] (Fig. 12), the former the larger, extending across the back, and the scutellum a

[41] There are in many insects, as in many Lepidoptera and Hymenoptera and some Neuroptera, four tergal pieces, i. e., præscutum, scutum, scutellum, and postscutellum, the first and fourth pieces being usually very small and often obsolete.

smaller, central, shield-like piece. The protergum, or what is usually in the books called the prothorax, represents either the scutum or both scutum and scutellum, the two not being differentiated.

The fore wings are long and narrow, and thicker than the hinder, which are broad, thin, and membranous, and most active in flight, and folded up like a fan when at rest and tucked away out of sight under the fore wings, which act as wing-covers.

Turning now to the side of the body under the insertion of the wing (Fig. 13), we see that the side of each of the middle and hind thoracic rings is composed of two pieces, the anterior, *episternum*, resting on the sternum, with the *epimerum* behind it; these pieces are vertically high and narrow, and to them the leg is inserted by three pieces, called respectively *coxa*, *trochantine*, and *trochanter* (see Fig. 13), the latter forming a true joint of the leg.

The legs consist of five well-marked joints, the *femur* (thigh), *tibia* (shank), and *tarsus* (foot), consisting in the locust of three joints, the third bearing two large claws with a pad between them. The hind legs, especially the femur and tibia, are very large, adapted for hopping.

The sternum is broad and large in the middle and hind thorax, but small and obscurely limited in the prothorax, with a large conical projection between the legs.

The head is mainly, in the adult locust, composed of a single piece called the *epicranium* (Figs. 13 and 13½, E), and which carries the eyes, ocelli, or simple eyes (Fig. 13½, *e*), and antennæ. While there are in reality four primary segments in the head of all winged insects, corresponding to the four pairs of appendages in the head, the posterior three segments after early embryonic life in the locust become obsolete, and are mainly represented by their appendages and small portions to which the appendages are attached. The epicranium represents the antennal segment, and most of the piece represents the tergum of the segment. The antennæ, or feelers, are inserted in front of the eyes, and between them is the anterior ocellus, or simple eye, while the two posterior ocelli are situated above the insertion of the antennæ. In front of the epicranium is the *clypeus* (Fig. 13), a piece nearly twice as broad as long. To the clypeus is attached a loose flap, which covers the jaws when they are at rest. This is the upper lip or *labrum* (Fig. 13). There are three pairs of mouth-appendages: first, the true jaws or mandibles (Fig. 12), which are single-jointed, and are broad, short, solid, with a toothed cutting and grinding edge, adapted for biting. The mandibles are situated on each side of the mouth-opening. Behind the mandibles are the maxillæ (Fig. 12), which are divided into three lobes, the inner armed with teeth or spines, the

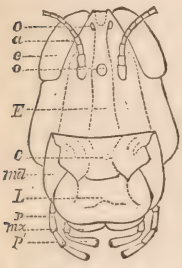

FIG. 13½.—Front view of the head of *C. spretus*.—E, epicranium; C, clypeus; L, labrum; *o o*, ocelli; *e*, eye; *a*, antenna; *md*, mandible; *mx*, portion of maxilla uncovered by the labrum; *p*, maxillary palpus; *p'*, labial palpus. (Kingsley *del.*)

middle lobe unarmed and spatula-shaped, while the outer forms a five-jointed feeler called the *maxillary palpus*. The maxillæ are accessory jaws and probably serve to hold and arrange the food to be ground by the true jaws. The floor of the mouth is formed by the *labium* (Figs. 12 and 13), which in reality is composed of two second maxillæ, soldered together in the middle, the two halves being drawn separately in Fig 12.

Within the mouth, and situated upon the labium, is the tongue (*lingua*), which, as observed in *C. femur-rubrum*, is a large, membranous, partly hollow expansion of the base of the labrum; it is somewhat pyriform, slightly keeled above, and covered with fine, stiff hairs, which, under a one-fifth lens, are seen to be long, rough, chitinous spines, with one or two slight points or tubercles on the side. These stiff hairs probably serve to retain the food in the mouth, and are, apparently, of the same structure as the teeth in the proventriculus. The base of the tongue is narrow, and extends back to near the pharynx (or entrance to the gullet), there being on the floor of the mouth, behind the tongue, two oblique slight ridges, covered with stiff, golden hairs, like those on the tongue.

INTERNAL ANATOMY.

The *œsophagus* (Fig. 14, *a*) is short and curved, continuous with the roof of the mouth. There are several longitudinal irregular folds on the inner surface. It terminates in the center of the head, directly under the supra-œsophageal ganglia, the end being indicated by several small conical valves closing the passage, thus preventing the regurgitation of the food.

The œsophagus is succeeded by the crop (*ingluvies*). It dilates rapidly in the head, and again enlarges before passing out of the head, and at the point of first expansion or enlargement there begins a circular or oblique series of folds, armed with a single or two alternating rows of simple spine-like teeth. Just after the crop leaves the head the rugæ or folds become longitudinal, the teeth arranged in rows, each row formed of groups of from three to six teeth, which point backwards so as to push the food into the stomach. In alcoholic specimens the folds of the crop and œsophagus are deep blood-red, while the muscular portion is flesh-colored. It is in the crop that the "molasses" thrown out by the locust originates, as we have found the fluid in opening the crop of living specimens, and it consists of partially digested food. The crop terminates a little behind the insertion of the middle pair of legs.

The *proventriculus* is very small in the locust, easily overlooked in dissection, while in the green grasshoppers it is large and armed with sharp teeth. It forms a neck or constriction between the crop and true stomach. It may be studied by laying the alimentary canal open with a pair of fine scissors, and is then seen to be armed with six flat folds, suddenly terminating posteriorly, where the true stomach (chyle-stomach,

ventriculus) begins. The chyle-stomach is about one-half as thick as the crop, when the latter is distended with food, and is of nearly the same diameter throughout, being much paler than the reddish crop, and of a flesh-color.

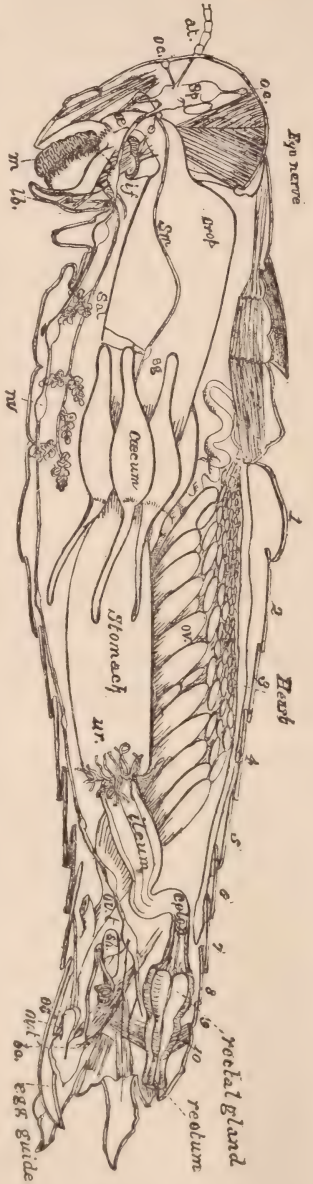

FIG. 14.—INTERNAL ANATOMY OF CALOPTENUS FEMUR-RUBRUM.—*at*, antenna and nerve leading to it from the "brain" or supra-œsophageal ganglion (*sg*); *oc*, ocelli, anterior and vertical ones, with ocellar nerves leading to them from the "brain"; *œ*, œsophagus; *m*, mouth; *lb*, labium or under lip; *if*, infra-œsophageal ganglion, sending three pairs of nerves to the mandibles, maxillæ and labium respectively (not clearly shown in the engraving); *Sm*, sympathetic or vagus nerve, starting from a ganglion resting above the œsophagus and connecting with another ganglion (*sg*) near the hinder end of the crop; *sal*, salivary glands (the termination of the salivary duct not clearly shown by the engraver); *n*, nervous cord and ganglia; *ov*, ovary; *ur*, urinary tubes; *ovt*, oviduct; *sb*, sebaceous gland; *bc*, bursa copulatrix; *ovt'*, site of opening of the oviduct (the left oviduct cut away); 1–10, abdominal segments. The other organs labeled in full. (Drawn from his original dissections by Mr. Edward Burgess.)

From the anterior end arise six large *gastric cæca*, the anterior division surrounding the posterior third of the crop long, pea-shaped, whitish, and containing a whitish, emulsion-like fluid. When distended, they touch each other. Each cæcum sends back a posterior division, separated by a slight constriction from the anterior division; they are long and slender, and rest or float freely in the body-cavity, while the anterior divisions are bound down to the digestive canal. These cæca are dilatations of the true chyle-stomach, and probably serve to present a larger surface from which the chyle may escape into the body-cavity and mix with the blood, there being in insects no lacteal vessels or lymphatic system. Within the anterior division are from 8 to 10 longitudinal folds. (In a living transparent dipterous larva, probably one of the *Mycetophilidæ* found living in flower-pots, we have observed the digested food oscillating back and forth from the stomach into the two large, long, simple cæca. The stomach was filled with food, and it appeared as if the chyle were passing into the cæca.)

The stomach ends at the posterior edge of the fourth abdominal segment in a slight constriction, at which point (pyloric end) the urinary tubes (*vasa urinaria*, Fig. 14, *ur*) arise. These are arranged in 10 groups

of about 15 tubes, so that there are about 150 tubes in all; at their insertion the tubes radiate from the center, and there is a well-marked space on the circumference of the canal between the groups of the tubes. These vessels are very long; when stretched out about as long as the body, but are usually much convoluted and wound around the alimentary canal, a few reaching as far as the head. These are excretory organs, and correspond to the kidneys of the vertebrate animals. The terminal portions of a few only of these tubes are represented in Fig. 14.[42]

The *intestine* (ileum) lies in the fifth and sixth abdominal segments; it gradually diminishes in thickness, and while the surface of the chylestomach is smooth, with fine longitudinal muscular fibers, the surface of the intestine has about 12 or 15 large longitudinal ridges, with a few smaller ones.

Behind the intestines is the *colon*, which is smaller than the intestine proper, and makes a partial twist. Its surface is smooth. The colon suddenly expands into the *rectum*, with 6 large *rectal glands* on the outside, held in place by 6 muscular bands attached anteriorly to the hinder end of the colon. In cross-section through the middle of the mass of glands they are seen to be hollow, their cavities independent of that of the rectum, though there is an intimate communication between the two. The nature of these glands is unknown. They are lined with epithelial cells and are secretory in their function, and, as Chun observes, they probably compensate for the want of epithelial secretory cells in the lining of the rectum. The rectum turns up toward its end, and the anus is situated just below the supra-anal plate in the male, while in the female it is placed between the supra-anal plate and the upper pair of spines of the ovipositor.

In closing our account of the digestive canal, we should briefly describe the salivary glands (Fig. 14, *sal.*) These are rather difficult to find, as they lie on the floor of the thorax and are partly covered by muscles and various tissues. The two ducts may be found passing back from under the infra-œsophageal ganglion, and pass straight backward, ending just in front of the insertion of the third pair of legs, and dividing into no large branches. A small lateral twig with scattered follicles lies in the prothorax on the outside of the main duct. Behind this is a second mass of follicles like a bunch of grapes attached to two small twigs, one on each side. There is a third large assemblage of follicles lying on each side of the second thoracic ganglion, under the metascutum. The two main ducts, according to Mr. Burgess's observations, as seen in his drawing (Fig. 14), unite just before opening into the base of the mouth near the tongue. Our observations were made on *Caloptenus femur-rubrum*, as were those of Mr. Burgess. The salivary glands are much simpler and smaller in the locusts than in any other family of Orthoptera.

[42] We are indebted to Mr. E. Burgess, of Boston, Mass., for the drawing of Fig. 14, made expressly for, and free of expense to, the Commission.

Having described in a very general way the digestive canal of the locust, we may state in a summary way the functions of the different divisions of the tract, following the conclusions of Prof. F. Plateau.[43] The food after being cut up by the jaws is acted upon while in the crop by the salivary fluid, which is alkaline, and possesses the property, as in vertebrates, of rapidly transforming the starchy elements of the food into soluble and assimilable glucose. The digestive action carried on in the crop (*ingluvies*) then, in a vegetable-feeding insect like the locust, results in the conversion of the starchy matters into glucose or sugar. This process goes on very slowly. When digestion in the crop has ended, the matters submitted to an energetic pressure by the walls of the crop, which make peristaltic contractions, filter gradually through the short small gizzard (proventriculus), directed by the furrows and chitinous projections lining it. The apparatus of teeth does not triturate the food, which has been sufficiently comminuted by the jaws. This is proved by the fact, says Plateau, that the parcels of food are of the same form and size as those in the crop, before passing through the gizzard. The six large lateral pouches (cœca) emptying into the commencement of the stomach (ventriculus) are true glands, which secrete an alkaline fluid, probably aiding in digestion. In the stomach (ventriculus) the portion of the food which has resisted the action of the crop is submitted to the action of a neutral or alkaline liquid, never acid, secreted by special local glands or by the lining epithelium. In the ileum and colon active absorption of the liquid portion of the food takes place, and the intestine proper (ileum and colon) is thus the seat of the secondary digestive phenomena. The reaction of the secretion is neutral or alkaline. The rectum is the stercoral reservoir. It may be empty or full of liquids, but never contains any gas. The liquid products secreted by the urinary tubes are here accumulated, and in certain circumstances here deposit the calculi or crystals of oxalic, uric, or phosphatic acid. Insects, says Plateau, have no special vessel to carry off the chyle, such as the lacteals or lymphatics of vertebrates; the products of digestion, viz, salts in solution, peptones, sugar in solution, and emulsionized greasy matters, pass through the fine coatings of the digestive canal by osmosis, and mingle outside of this canal with the currents of blood which pass along the ventral and lateral parts of the body.

Into the pyloric end of the stomach empty the urinary tubes, their secretions passing into the intestine. These are organs exclusively depuratory and urinary, relieving the body of the waste products. The liquid which they secrete contains urea (?), uric acid, and urates in abundance, hippuric acid (?), chloride of sodium, phosphates, carbonate of lime, oxalate of lime in quantity, leucine, and coloring matters.

The nervous system.—As observed in *Caloptenus spretus*, *C. femur-*

[43] Recherches sur les Phénomènes de la Digestion chez les Insectes. Bruxelles, 1874.

rubrum, and *C. bivittatus*, the nervous system does not vary at all, at least so as to afford any specific characters. The following general account of the nervous cord is based on that of the Rocky Mountain locust, while, in working out the minor points, such as the nerves of the end of the abdomen and the sympathetic (vagus) nerves and ganglia, specimens of *C. femur-rubrum* were used.

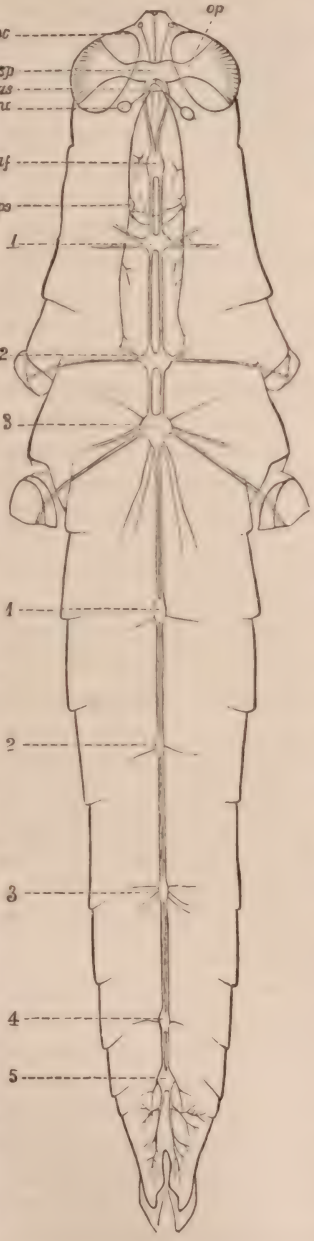

FIG. 15.—NERVOUS SYSTEM OF CALOPTENUS SPRETUS.—*sp*, supra-œsophageal ganglion, sending off the large optic nerve (*op*) to the eyes, and an ocellar nerve to each ocellus (the dotted line *oc* stops short of the left ocellus); *if*, infra-œsophageal ganglion; 1, 2, 3, thoracic ganglia; 1–5, five abdominal ganglia (the fifth the largest, and sending branches to the ovipositor, etc.). The sympathetic nerve and ganglia are represented by the two main nerves which arise from the medio-cephalic ganglion (*ps*) resting on and above the œsophagus and two ganglia (*ps*) on the under side of the crop. From each of these ganglia two nerves are sent under the crop, and a larger nerve on each side to as far as the stomachal cœca, ending in the figure at the dotted line 2, near the second thoracic ganglion. *at*, a round, shining body, connected by a nerve with the medio-cephalic ganglion, its nature unknown. (Drawn by J. H. Emerton from dissections made by Packard.)

The nervous system of the locust, as of other insects, consists of a series of nerve-centers, or so-called brains (ganglia), which are connected by two cords (commissures), the two cords in certain parts of the body in some insects united into one. There are in the locust 10 ganglia, 2 in the head, 3 in the thorax, and 5 in the abdomen. The first ganglion is rather larger than the others, and is called the brain. It is compressed from before and behind, being quite deep, while the other ganglia are more or less lens-shaped and flattened vertically. The brain rests upon the œsophagus, whence its name, supra-œsophageal ganglion. From the brain arise the large, short, optic nerves (Fig. 14, not lettered, but represented by the circle behind the brain, *sp*; Fig. 15, *op*), which go to the compound eyes, and from the front arise the three slender filaments which are sent to the three ocelli (Fig. 14, *oc*). From immediately in front, low down, arise the antennal nerves (Fig. 14, *at*).

The infra-œsophageal (*if*), as its name implies, lies under the œsophagus at the base of the head, under a bridge of chitine, and directly behind the tongue. It is connected with the supra-œsophageal ganglion by two commissures passing up each side of the œsophagus. From the

under side of the infra-œsophageal ganglion arise three pairs of nerves, which are distributed to the mandibles, maxillæ, and labium. The mandibular nerves project forward and arise from the anterior part of the ganglion, near the origin of the supra-œsophageal commissures, while the maxillary and labial nerves are directed downward into those organs.

The first thoracic ganglion is considerably larger than the infra-œsophageal, and lies on the floor of the body opposite the insertion of the fore legs, and under the center of the protergum. The second thoracic ganglion is larger than the first, and lies a little behind the insertion of the middle pair of legs, in the mesothoracic segment. It sends off a pair of large nerves to the hind legs, the nerves arising a little in advance of the middle of the ganglion. Five pairs of small nerves are distributed (two to the organs of hearing) to parts, &c. lying in the base of the abdomen. Other nerves are distributed from the two thoracic ganglia to the muscles of flight and walking. Of the five abdominal ganglia the first is small and white, while those anterior to it are red; it is situated in the third abdominal segment. The second abdominal ganglion lies in the fifth abdominal segment. The third abdominal ganglion lies in the seventh segment, the fourth in the eighth segment, and the fifth in the ninth segment. The fourth and fifth are near together, and the fifth is considerably larger than the fourth, while the commissures connecting them are much thicker than in the rest of the abdomen, those between the second thoracic and first abdominal ganglia being very small. (The remaining description is drawn up from dissections of *C. femur-rubrum.*)

The last or fifth abdominal ganglion sends off a lateral nerve (Fig. 14, thrown off just above the letters *sb*), which is distributed to the sebific gland and *bursa copulatrix*. From the posterior edge of the ganglion four nerves are distributed to the muscles of each spine of the ovipositor in the female, and small nerves are distributed to the large air-sacs. There is considerable variation in the distribution and number of these nerves. The ganglion lies directly over the point of junction of the two ovarian ducts which unite to form the common oviduct, and it partly covers the sebific (or sebaceous) gland.

The sympathetic ganglia are three in number; one situated just behind the supra-œsophageal ganglion (Fig. 15, *as*), resting on the œsophagus, and two others situated each side of the crop, low down. Each of the two posterior ganglia is supplied by a nerve from the anterior ganglion. Two nerves pass under the crop connecting the posterior ganglia, and from each posterior ganglion a nerve is sent backward to the end of the proventriculus. A pair of nerves pass under the œsophagus from each side of the anterior sympathetic ganglion, and another pair pass downward to a round white body, whose nature is unknown (Fig. 15, *u*).

The heart.—This organ (Fig. 14) is imperfectly understood in the locust, and, indeed, in the Orthoptera generally. So far as we could discover, the heart is a long tube, lying in the abdomen, dilating at six places along its course, and ending in a conical point near the end of the ab-

domen; it is held in place by fine muscular bands, as usual; it was not traced beyond the base of the abdomen.

The tracheæ and dilated air-sacs or respiratory organs.—As the air-tubes and air-sacs are intimately associated with the great powers of flight possessed by the locust, particular attention has been given to their topographical anatomy. The following description is based on a study of living specimens of *Caloptenus femur-rubrum* and *Œdipoda sordida*, as they had to be conducted in the laboratory at the close of the field-work in the West.

All insects breathe by means of a complicated system of air-tubes ramifying throughout the body, the air entering through a row of spiracles, or air-holes, or breathing-holes (*stigmata*), in the sides of the body. There are, as a rule, in locusts two pairs of thoracic and eight pairs of abdominal spiracles. The first thoracic pair (Fig. 16) is situated on the membrane connecting the prothorax and mesothorax, and is covered by the hinder edge of the protergum (usually called prothorax). The second spiracle is situated on the posterior edge of the mesothorax. There are eight abdominal spiracles, the first one situated just in front of the auditory sac or tympanum (see Fig. 13), and the remaining seven are small openings along the side of the abdomen, as indicated in Fig. 16. From these spiracles air-tubes pass in a short distance and connect on each side of the body with the *spiracular trachea* (Fig. 17, s, Fig. 16, s), as we may call it. These spiracular tracheæ begin at the posterior spiracle, and extend forward into the mesothorax, there subdividing into several branches. Branches from them pass to the two main *ventral* tracheæ (Fig. 16, v), and to the two main *dorsal* tracheæ (Fig. 17, D, Fig. 16, D). The main tracheal system in the abdomen, then, consists of six tubes, three on a side, extending along the abdomen. The pair of ventral tracheæ extend along the under side of the digestive canal; the dorsal tracheæ rest on the digestive canal. These six tubes are connected by anastomosing tracheæ, and, with their numerous subdivisions and minute twigs and the system of dilated tracheæ or air-sacs, an intricate net-work of tracheæ is formed.

The system of thoracic air-tubes is quite independent of the abdominal system, and not so easy to make out. The tubes arising from the two thoracic stigmata are not very well marked; they, however, send two well-marked tracheæ into the head (Figs. 17, *c*, 16, *c*), which subdivide into the ocular dilated air-tube (Figs. 17, *o c*, 16, *o c*) and a number of air-sacs in the front of the head.

The series of large abdominal air-sacs, of which there are five pairs (Fig. 17, $_{3\text{-}7}$), arise independently of the main tracheæ directly from branches originating from the spiracles, as seen in Fig. 16. They are large and easily found by raising the integument of the back. There is a large pair in the mesothorax (Fig. 17, $_2$), and two enormous sacs in the prothorax (Fig. 17, $_1$), sometimes extending as far back as the anterior edge of the mesothorax. All these sacs are superficial, lying next to the

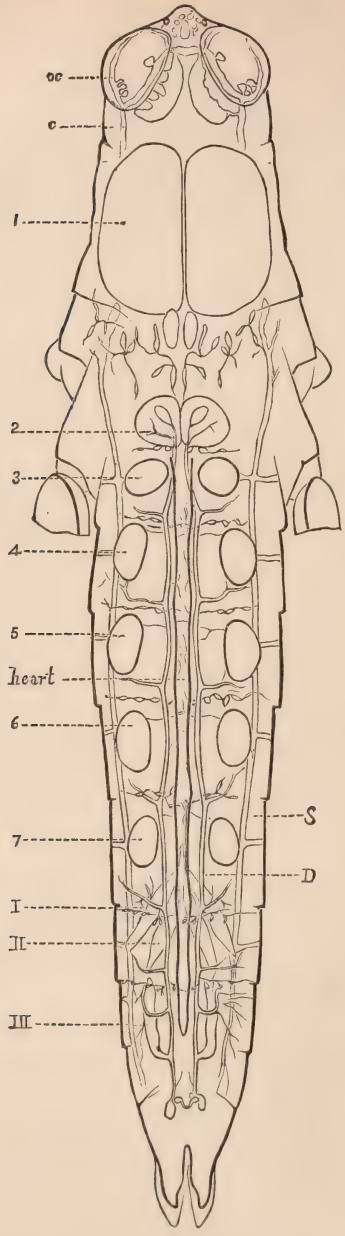

FIG. 17.

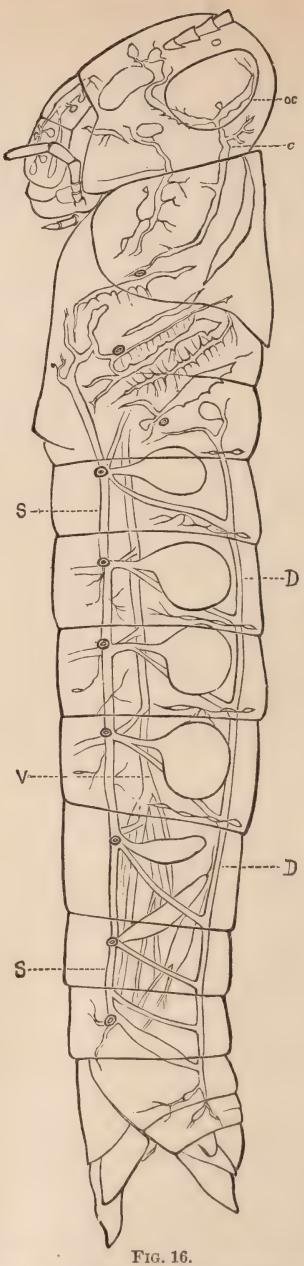

FIG. 16.

FIG. 16.—SHOWING DISTRIBUTION OF AIR-TUBES (TRACHEÆ) AND AIR-SACS.—Side view of the body. V, main ventral trachea (only one of the two shown); S, left stigmatal trachea, connecting by vertical branches with D, the left main dorsal trachea; *c*, left cephalic trachea; *oc*, ocular dilated trachea. From the first, second, third, and fourth spiracles arise the first four abdominal air-sacs, which are succeeded by the plexus of three pairs of dilated tracheæ, I, II, III, in Fig. 17. Numerous air-sacs and tracheæ are represented in the head and thorax. The two thoracic spiracles are represented, but not lettered.

FIG. 17.—D, left dorsal tracnea; S, left stigmatal trachea; I, II, III, first, second, and third pairs of abdominal dilated tracheæ, forming a plexus behind the ovaries; 1, pair of enormous thoracic air-sacs; 2, pair of smaller air-sacs; 3–7, abdominal air-sacs; *oc*, ocular dilated trachea and air-sacs; *c*, cephalic trachea. The relations of the heart to the dorsal tracheæ are indicated. (Drawn by Emerton from dissections by Packard.)

hypodermis or inner layer of the integument, while the smaller ones are, in many cases, buried among the muscles. Between the first and second thoracic sacs is a pair of small ones with numerous others still smaller. From the dorsal tracheæ arise series of minute subcutaneous air-sacs. Besides these ordinary air-sacs there is in the end of the abdomen, behind the ovaries, a plexus of six dilated air-sacs (Figs. 16 and 17, I, II, III), which are long, spindle-shaped, and are easily detected in dissecting. Behind them, in the extreme end of the abdomen, are three pairs of small rounded air-sacs, and there is a complicated system of dilated tracheæ among the muscles of the ovipositor. Between the six gastric cæca are six dilated air-tubes.

The system of dilated tracheæ and air-sacs in the head is rather complicated, and the following description is based on vivi-dissections of *Caloptenus femur-rubrum* and *Œdipoda sordida*. Of the air sacs there is a median one (not represented in the figures) in the posterior edge of the head, and buried between the muscles and resting directly on the crop. Between the eyes are two large sacs (seen in Fig. 17), arising from the main cephalic tracheæ; these air-sacs connect with an unpaired median transverse sac. Under the eyes are four sacs connected together by tracheæ, and in fact this whole region contains a large number of subcutaneous air-sacs. The main cephalic tracheæ subdivide, and send two branches around the eye under the cornea (Figs. 16 and 17, *oc*, ocular tracheæ), and from these ocular tracheæ are sent off numerous subcutaneous sacs. On the vertex between the eyes and insertion of the antennæ are nine sacs of unequal size, one median, one being larger than the eight others. There is also a pair of sacs on the extreme vertex and two pairs behind the eyes; a little in front of the antennæ are four well-marked median round sacs, and two much smaller ones. Along the front edge of the clypeus is a large transverse dilated trachea, from which four tracheæ, two on each side, the external ones the smallest, pass down to the front edge of the labrum, and send off a number of small spherical sacs, so that in the labrum alone there are about 16 air-sacs. We have found 53 air-sacs in all in the head of the locust. The lateral region between the base of the jaws and the vertex is quite free from air-sacs, as we have not detected more than four or five quite small ones.

In the legs (described from *Œ. sordida*) two tracheæ pass down each side of the femora, sending off at quite regular intervals numerous much-branching transverse twigs; there is one large and a very small trachea in the tibia, and the main one extends to the extremity of the last tarsal joint. There are four slender air-sacs at the base of the femora.

Mode of breathing.—By holding the Red-legged locust in our hand we observed the mode of breathing. During this act the portion of the side of the body between the stigmata and the pleurum (Fig. 12, A) contracts and expands; the contraction of this region causes the spiracles to open. The general movement is caused by the sternal

moving much more decidedly than the tergal portion of the abdomen. When the pleural portion of the abdomen is forced out, the soft pleural membranous region under the fore and hind wings contracts, as does the tympanum and the membranous portions at the base of the hind legs. When the tergum or dorsal portion of the abdomen falls, and the pleurum contracts, the spiracles open; their opening is nearly but not always exactly co-ordinated with the contractions of the pleurum, but as a rule they are. There were 65 contractions in a minute in a locust which had been held between the fingers about ten minutes. It was noticed that when the abdomen expanded the air-sacs in the first abdominal ring contracted. This would indicate that the air rushes into the spiracles during the contraction of the abdomen, and that the air-sacs are not refilled until the spiracles are closed; thus the air in the air-sacs is perhaps constantly changing.[44]

The locust an aëronaut.—It is evident that the enormous powers of flight possessed by the locust, especially its faculty of sailing for many hours in the air, is due to the presence of these air-sacs, which float it up in the atmospheric sea. Other insects with a powerful flight, as the bees and flies, have well-developed air-sacs, but they are less numerous. In a grasshopper (*Truxalis*), as figured by Marcel de Serres, the air-sacs are as numerous as in the normal *Acrydii*, but they are more developed in the locust family (*Acrydii*) than in the green grass-hoppers (*Locustariæ*).

It will be seen that, once having taken flight, the locust can buoy itself up in the air, constantly filling and refilling its internal buoys or balloons without any muscular exertion, and thus be borne along by favorable winds to its destination. It is evident that the process of respiration can be best carried on in clear, sunny weather, and that when the sun sets, or the weather is cloudy and damp, its powers of flight are lessened, owing to the diminished power of respiration.

The male reproductive system.—As observed in *C. spretus* and more carefully in *C. femur-rubrum*, each testis is closely united to the other, so as to form a single mass of tubular glands, arranged vertico-obliquely, and interpenetrated by simple and dilated tracheæ. The mass rests on the intestines, and is situated in the third, fourth, and fifth abdominal segments. The anterior end of the testicular mass is rounded and held in place by a broad, thin band, one on each side; two similar bands are situated a little behind the middle of the mass.

From the under side, and a little in advance of the middle of the mass, two straight small ducts, as long as the testicular mass, pass obliquely to the sides of the body, at the posterior end of the seventh segment of the abdomen; these are the *vasa deferentia*. Each *vas deferens* with its mate forms a convoluted mass of tubes, comprising 20 folded bundles (*epididymis* of Dufour), and two single, long, convoluted tubes, the *vesiculæ seminales*.

[44] It was noticed in a species of *Gryllus* or cricket (*G. neglectus?*) that there are no air-sacs, but dilated tracheæ somewhat like those in *Caloptenus*. It is evident that in those Orthoptera which do not take long flights there is no need of air-sacs. They are most developed in those insects which fly most.

In *C. femur-rubrum*, the epididymis forms a longer, slenderer bundle than in *C. spretus* or *C. bivittatus*.

The vesiculæ seminales are lodged in the 6th and 7th segments of the abdomen. The two vesiculæ unite over the fifth abdominal ganglion and form a thick, very short duct (*ductus ejaculatorius*), which passes into a large spherical muscular mass (*præputium*), behind which is the large intromittent organ (*penis*), which forms a short chitinous cylinder, complicated in structure, and differing considerably in the four common species of *Caloptenus* (*C. spretus*, *atlanis*, *femur-rubrum*, and *bivittatus*), and affording excellent specific characters. The penis can be seen in place without dissection by drawing back the orbicular convex piece called the *velum penis*. The penis is armed with hooks and projections. The organ and its armature are much alike in *C. spretus* and *C. atlanis*; *C. femur-rubrum* differs from both, while in *C. bivittatus* it is like that of *C. atlanis*.

The female reproductive system.—The ovaries (Fig. 14, *ov*) form a large mass, just before oviposition, distending the abdomen somewhat, and crowding the intestine a little out of place. The ovaries consist of two masses of tubes, each mass tied to the other by slight bands, with air-sacs and tracheæ ramifying among them. There are from 17 to 22 tubes arranged in two rows in each ovary in *Caloptenus femur-rubrum*; in one *C. spretus* we counted 50 tubes in each ovary, making 100 in all. Each tube averages about 8 millimeters in length, and contains about 10 rudimentary eggs, besides the nearly ripe ones (though only from thirty to one hundred eggs are laid). These tubes lie along the intestine and extend into the prothorax. They communicate, though not freely, there being apparently a thin membrane opposed to the free passage of the eggs, with the common ovarian duct, which is greatly prolonged, entering into a long, somewhat twisted, slender tube, which connects with its fellow, and serves to hold the two ovaries together. The two tubes pass down on each side of the intestine, and unite to form the oviduct, which lies on the floor of the abdomen. It is as long as a ripe egg. Above the opening of the duct, and directly communicating with it, is the *bursa copulatrix*, a capacious pouch lined within with several narrow, longitudinal, chitinous bands. Behind the *bursa copulatrix* lies, partly resting under the fifth abdominal ganglion, the sebific or colleterial gland (Fig. 14, *sb*), which is flattened, pear-shaped, a little over half as long as a ripe egg. From the under side, a little in advance of the middle, arises the *sebific duct* (Fig. 14), which, after making three tight coils next to the ganglion, passes back and empties into the upper side of the *bursa copulatrix*, dilating slightly before its junction with the latter. The sebific gland secretes a copious supply of a sticky fluid, which is poured out as the eggs pass out of the oviduct, and agglutinates the eggs into a mass, forming a thin coating around each egg, which from mutual pressure of the eggs causes the tough coating to be pitted hexagonally. The above description will apply to *C. spretus*, *C. femur-rubrum*, and *C. bivittatus*, the parts within not differing specifically.

The external parts consist of the ovipositor (Fig. 12, B, and Fig. 14), which is formed of two pairs of spines (*rhabdites*) adapted for boring into the earth, and the egg-guide (Figs. 12 and 14, *eg*), a triangular flap, guarding the under side of the opening of the oviduct.

Organs of special sense.—It is difficult to explain many of the actions of our migratory locust, from the fact that it is hard for us to appreciate the mental powers, instincts, and general intelligence of insects. That they have sufficient intellectual powers to enable them to maintain their existence may be regarded as an axiom. But insects differ much in intelligence and also in the degree of perfection of the organs of sense. The intelligence of insects depends, of course, largely on the development of the organs of special sense.

The sense of sight must be well developed in the locust, there being two large, well-developed compound eyes, and three simple ones (*ocelli*) situated between the former, supplied with nerves of special sense.

The antennæ are, in the locust, organs of touch. The palpi are not only organs of touch, but probably, as in some other insects, are endowed with the sense of taste, enabling the locust to discriminate between the different kinds of food, and select that best adapted to suit its wants. It is possible that the labial nerves send branches of special sense to the tongue, but this is a subject which has not been worked out as regards the *Acrydii*.

The ears are well developed in the locust, and we know that the sense of hearing must be delicate, not only from the fact that a loud alarum with kettles and pans affects them, but the movements of persons walking through the grass invariably disturb them. Besides this, they produce a fiddling or stridulating sound by rubbing their hind legs against their folded wing-covers, and this noise is a sexual sound, heard and appreciated by individuals of the other sex. Any insect which produces a sound must be supposed to have ears to hear the sound produced by others of its species.

The ears (or auditory sacs) of the locust are situated, one on each side, on the basal joint of the abdomen, just behind the first abdominal spiracle (Fig. 13).

The apparatus consists of a tense membrane, the *tympanum* surrounded by a horny ring. "On the internal surface of this membrane are two horny processes, to which is attached an extremely delicate vesicle filled with a transparent fluid, and representing a membranous labyrinth. This vesicle is in connection with an auditory nerve, which arises from the third thoracic ganglion, forms a ganglion upon the tympanum, and terminates in the immediate neighborhood of the labyrinth by a collection of cuneiform, staff-like bodies, with very finely-pointed extremities (primitive nerve-fibres?), which are surrounded by loosely aggregated ganglionic globules."—(Siebold's Anatomy of the Invertebrates.)

The following account of the histology of the digestive system of the locust is appended. It has been prepared by Dr. Charles Sedgwick Minot, of Boston, Mass.

REPORT ON THE FINE ANATOMY OF THE LOCUST.

By Charles Sedgwick Minot.

Most attention has been directed to the structure of the digestive and reproductive organs. As the nature of the work required the use of fresh materials from living specimens, and as I was unable to secure in Boston living locusts from the Rocky Mountains, I have been obliged to make my observations upon the New England species, *Caloptenus femur-rubrum*. This, however, was a matter of little importance, for the interior structure of the Eastern species is almost the same as that of the Rocky Mountains, so that an anatomical description of the one applies almost word for word to the other.

The investigation has been supplemented by some comparison with other insects in order to determine, as far as the time at my disposal allowed, in what points the structure of the locust is peculiar.

I must first remark that every digestive canal in quadrupeds and snails, as well as insects, consists of four physiologically distinct parts. In the first place are found the organs for the mechanical seizure of the food and swallowing, the jaws, mouth, and œsophagus. They serve to seize the food, often to tear it up mechanically, and to transport it to the interior of the body where it is to be digested. In the locust these organs form a very complex system. In the second place comes the stomach and parts where the digestive juices, properly so-called, are secreted. In this portion the chemical nature of the food is altered, rendering the mass suitable for absorption, which takes place in the third part of the digestive canal. The second and third parts are often not separated from one another, but we find in the wall of the intestine the organs of absorption and the digestive glands lying alongside one another. Finally, in the fourth part, which is usually the terminal end of the tract, the effete and indigestible masses are accumulated and are finally expelled, being of no further use in the economy of the animal. This terminal portion is usually called the rectum, the Latin word for straight. This term was originally applied to man, in whom this portion of the intestine is straight. Since then it has been employed for the analogous parts in animals, and often serves to designate a structure which is very far from being straight. The rectum is well nigh invariably supplied with muscles, by means of which it accomplishes the act of expulsion of the fæces.

We will now proceed to describe the peculiarities of these four divisions in the locust. We begin by an account of the general course of the digestive tract from the mouth to the anus.

The digestive canal begins in the head with the cavity of the mouth, bounded inferiorly by the jaws and other appendages, and above by the buccal plates; it extends upward and forward from one-fifth to one-fourth of the way through the head. Its walls are black, in this respect entirely different from the rest of the canal.

The œsophagus is distinctly marked off from the buccal cavity, though the direct continuation of it. The œsophagus runs at first upward and forward, and then, making an elbow, continues upward and backward until it attains the middle of the upper half of the head, just above and behind the brain, or supra-œsophageal ganglion, where it gradually widens both its transverse and vertical diameters to form the crop, where the digestion proper begins, according to Professor Felix Plateau. The crop is marked off anteriorly by a slight constriction. The walls of the œsophagus, and, indeed, of the whole digestive canal as far as the ventricle, are of a brownish-red color, and thrown up into folds covered by a hard chitinous layer, and armed with projecting spines and processes. In the œsophagus the ridges run nearly longitudinally, and are not so high nor so well marked as in the crop.

The crop is that part of the intestinal canal which extends backward from the œsophagus through the three thoracic segments. It consists of two parts. The anterior, larger, and horizontal division lies in the posterior portion of the head and in the prothorax. Its diameter is especially variable, for its walls are capable of great distension. When filled with food its diameter becomes greater than any other part of the digestive tract; when empty, on the other hand, it contracts, and may become of less size than the ventricle. The posterior portion of the crop has hardly more than half the diameter of the front division; it tapers slightly backwards, as it descends through the two hinder segments of the thorax, and terminates in the rudimentary proventriculus (*Kaumagen*), which can be recognized by the six large folds or chitinous teeth. In the grasshoppers this organ is very much reduced in size, and appears, rather, merely as the terminal portion of the crop than as an independent structure. It is interesting to note this analogy, because in most other members of the order of Orthoptera the *Kaumagen* is very large, distinct, and of a very complicated structure.[45]

The anterior division of the crop is characterized by transverse ridges, the crests of which are covered by very hard chitine, which is thrown up into short, stout, and sharp spines that point backward. The office of the spines is evidently to aid the passage of the food down the digestive canal, and to prevent its regurgitation. The ridges are all transverse, but the anterior ones are wider than the others. Each ridge extends only one-third or one-half of the way around the crop, and finally they incline from above backward, while the posterior ridges are longer, narrower, and more nearly vertical in their course. At the point where the second division of the crop begins, there intervenes between the two parts a space in which the ridges are very irregular, running straight for very short distances only, and forming numerous sharp angles. In this manner the direction of the ridges from being transverse becomes first slightly, then very irregular, until they finally become longitudinal, which direction is characteristic for the posterior division of the crop.

[45] See *American Naturalist*, July, 1877, and Dr. Wilde's Untersuchungen über den Kaumagen der Orthopteren. *Archiv für Naturgeschichte*, 1877, *Heft* 1, *p.* 135.

The ridges all terminate just in front of the six large ridges or teeth which mark the proventriculus.

Dr. von Basch, in his treatise on the digestive tract of the Eastern cockroach (*Blatta orientalis*),[46] considers the whole series of divisions above mentioned to form collectively the anterior segment of the digestive organs. This view is, however, probably erroneous, for reasons that need not be detailed here. Professor Plateau has already shown that active digestion begins in the crop. The mouth and œsophagus can alone be considered merely as organs for the mechanical seizure and preparation of the food. The blades of grass upon which the grasshopper feeds are cut up into small oblong pieces, which are further divided in their passage through the œsophagus. But the chemical processes of digestion begin even in the mouth, for the salivary glands have their openings there, and their secretion has the power, according to both Basch and Plateau, of converting into sugar the starch which green plants always contain so abundantly. It will thus be seen that, strictly speaking, there is no part of the digestive canal which serves solely to masticate the food, but it is nevertheless proper to call the œsophagus and mouth the organs for the mechanical preparation of the food, for their walls do not, as far as we know, contribute at all to the digestive juices.

Far different is the case with the crop, which performs a double function, for not only does it continue the mechanical division of the food, but it also mixes it with an alkaline brown secretion, which it is supposed is poured out by the glandular walls of the crop itself. At any rate, the chemical changes in the food which render it suitable for absorption go on mainly in the crop, and not in the ventricle proper.

The function of the proventricle (*Kaumagen*) is stated by F. Plateau, and I think correctly, to have been misinterpreted by earlier writers, inasmuch as it is not an organ of mastication, but really only a filter and sort of valve, which allows the food to strain through when it has been sufficiently triturated.

The next division of the intestine is the stomach, or ventricle, which has very delicate glandular walls. The true structure has not been fully recognized by previous writers. It lies ventrally in the first to the fifth abdominal segment; it is nearly cylindrical, being somewhat enlarged anteriorly to receive the opening of the proventricle and to connect with the diverticula. In a median section, only one of these diverticula, or blind pouches, appears, though there are several others which lie on either side of the stomach. The shape and general anatomy of these appendices have been described in detail by Dr. Packard. I will here remark that they are decidedly different in their structure from the ventricle itself, and they prepare, according to Prof. Felix Plateau,[47] an alkaline secretion. In transverse sections of the pouches, there appear

[46] Sitzungsberichte der Wiener Akademie, xxxiii (1858), p. 234.

[47] Mémoires de l'Académie des Sciences, des Lettres et des Beaux-Arts de Belgique, tome xli, 1875, 2me mémoire.

projecting folds, formed by delicate epithelial cells; the folds resemble somewhat those that are found in the cæca of sharks, for instance.

The lining membrane of the ventricle is formed by cylindrical cells, which form little glands, separated from one another by walls of connective tissue, in a manner the details of which are reserved for my final report. The posterior limit of the stomach is marked by very peculiar structures, which, to my knowledge, have never before been described. They are particularly interesting because they present peculiarities which are not otherwise united in one organ. They are folds which project forward, twelve in number, and encircling the cavity of the intestine. When I first discovered them, I thought that I must by some mistake have examined, not the intestine, but the terminal portion of the digestive tract, where somewhat similar organs are found, and have long been known under the name of rectal glands (*Rectaldrüsen*). The intestinal folds are sharply limited, each with a convex border anteriorly, while posteriorly they gradually fade out. They are covered by large cylindrical cells, which in some cases are completely filled with pigment granules. These singular folds are found in the same position in *Caloptenus spretus* and *C. femur-rubrum* as in *Œdipoda sordida*, and their character is essentially the same in the three species. I anticipate that they will be found to occur in the grasshoppers and locusts generally, and perhaps even in many other insects.

Behind the folds, the intestine still continues straight onward in its course for about three segments. The histological character of this portion is singular, inasmuch as the epithelial cells which form its lining are of various sizes, some of them being large and others small, those of the same size forming longitudinal bands and slight folds. Next follows the colon, which ascends backward in a nearly straight line. Its lining membrane is thrown up into irregular folds, and has a brownish color. There is, however, no cuticula, as in the crop. These folds probably serve mainly as a filter, and to retain the food until the digestible part is absorbed.

The whole of the digestive tract between the proventricle and the rectum, that is to say, the ventricle, diverticula, intestine, and colon together, completes the process of digestion, and carries on that of absorption. In what manner this absorption is accomplished is still unknown.

The rectum is nearly straight and horizontal in its course, except terminally, where it turns upward to form the dorsally placed anus. It varies in size according to the amount of matter accumulated in it. It is especially characterized by the presence of six broad, longitudinal folds, and by the marked development of its muscular walls. In it the last traces of moisture in the digested masses are apparently absorbed, after which the ball is expelled through the vent. The rectum represents the fourth and last of the physiological divisions of the digestive tract.

The composition of the walls of the intestinal canal is essentially upon

one plan throughout. The lining membrane is a layer of epithelial cells, which are of various forms, characteristic for each division of the canal. This layer may or may not have an interior cuticula or thin homogeneous coat secreted by the cells. In all the front part of the canal, the cuticula is thick and resistant, and serves to form the hard ridges and spines in the œsophagus, crop, and proventricle. In the stomach, the cuticula is very thin and delicate, and I think, but am not sure, that it is there pierced by numerous minute pores, through which pass fine cilia. In the diverticula, the cuticula is somewhat more developed. On the intestinal folds, it is armed with very numerous and very delicate spines.

Outside of the layer of epithelial cells there comes first, at least in some parts, a very thin basement membrane, next to which follows the layer of connective tissue, and finally the muscles, which form a circular and a longitudinal coat, both of which are unequally and variously developed in the different segments of the tract.

The muscular and the connective layer are permeated by innumerable fine air-tubes, or tracheæ. The tracheæ themselves present the same histological peculiarities as those of other insects, and as I have described in my article on the tracheæ of the water-beetle (*Hydrophilus*) of Europe, published in the *Archives de Physiologie* in January, 1876. Externally there is a layer of flat epithelial cells, which secrete the spiral threads and inner chitinous coats.

My observations have also extended to other parts of the body, particularly to the genital system, and I shall be able in my final report to communicate many new observations on these organs. It does not seem to me, however, desirable to enter further into details at present, as it would be difficult to give any satisfactory account without the aid of figures. I have been able to trace some of the principal stages of development of the eggs and spermatozoa, but must reserve the discussion of them until later.

EMBRYOLOGY OF THE ROCKY MOUNTAIN LOCUST.

It was hoped that we should be able to give quite a full summary of the principal changes in the life of the locust before leaving the egg, but it has been found impracticable to do this. We therefore present the following description of the egg, and of the embryo just before hatching, taken, with some corrections and omissions, from Mr. Packard's Report on the Rocky Mountain Locust.[43]

The egg is curved, cylindrical, 0.21 inch (5½ millimeters) in length, more pointed at the posterior than the anterior end. The posterior end is contracted just before the extreme tip, which is smooth, the more or less regular pits in the crust which covers the chorion, or egg-shell, being here obsolete. We have been unable to discover any micropyle, or passage for the spermatozoa. The posterior end points downward in the egg-mass, so that the exit of the young locust from the anterior end is

[43] Report on the Rocky Mountain Locust and other Insects, &c., *loc. cit.*

thus rendered easier. The chorion is the egg-shell, and is a dense, rather thick, horny membrane. It is covered by a hard crust secreted by the sebific gland. This crust is pitted hexagonally. The ripe embryo is protected within the egg by two membranes. The outer is the *serous membrane*, and is of the form of and lies next to the chorion, while the inner is the *amnion*, and envelops the body and each separate limb. While this membrane in most insects is structureless, we have found that in the locust it is composed of convex cells, the membrane seen in outline being rough, like the cornea of an insect's eye. Although we have not seen the larva actually burst its way out of the egg in more than two instances, yet on the examination of between fifteen and twenty deserted egg-shells, we have, without an exception, noticed in them one, more usually two, slits extending from the head end to the middle of the egg. The egg-shell is without doubt burst open by the puffing-out or expansion of the membrane connecting the head and prothorax, just as the common house-fly, or flesh-fly, bursts off the end of its pupa-case by the puffing-out of the front of the head. In one case, we saw a large piece of the egg-shell (chorion) fly off from in front of the face while the face of the embryo puffed slightly out, and in another instance the whole anterior end of the shell came off. In the locust, we have observed, as will be seen farther on, that the amnion is ruptured by the forcible expansion of the membrane behind the head, the larvæ before walking lying on their backs or sides and forcing this membrane outward. This action probably begins before the shell is burst, and seems amply sufficient to burst the chorion and serous membrane. The outer crust deposited from the sebific gland is fragile and easily broken and peeled off by rubbing the egg between the fingers, leaving the chorion beneath. The pressure thus exerted must be a lateral one, and sufficient to rupture the dense chorion.

On removing the living embryo from the egg-shell (Fig. 18), it is found that it lies with the legs folded on the side of the body, the fore and middle pairs folded directly across the thorax, while the hind pair are laid along each side of the abdomen. The antennæ lie on the face, each side of the clypeus and labrum, or upper lip. The eyes are dark reddish, and the head, limbs, and cross-lines on the back of the body are reddish mixed with yellow. Beneath, the body and legs are white. By putting the eggs in alcohol, the shell becomes more transparent, so that the head, eyes, limbs, and reddish portions of the body become visible. Length of embryo at time of hatching, 0.21 inch. Described from living specimens received from Mr. S. D. Payne, Kasota, Le Sueur County, Minnesota, March 1, 1877. Either during the night of the 13th or early in the morning of the 14th of March, nearly all the larvæ (the eggs hav-

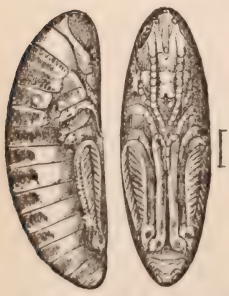

FIG. 18.—Embryo locust in the amnion. (After Emerton.)

ing been kept in a warm room) hatched at the same time. The egg-shell[49] bursts open at the head end, when the larva, soon after extricating itself from the egg, casts off a thin pellicle (the amnion, or *Faltenblatt*), as we have seen in the larvæ of the flea, currant saw-fly, and other insects. Before the skin is cast, the locust is almost motionless, and by slight movements of the body in about five minutes draws itself out of the amnion. The process of extrication is as follows: While the larva lies nearly motionless it puffs out the thin, loose skin connecting the back of the head with the front edge of the prothorax. The distension of this part probably ruptures the skin, which slips over the head, the body meanwhile curving over until the skin is drawn back from the head; when the latter is thrown back, the larva withdraws its antennæ and legs, and the skin is in a few seconds pushed back to near the end of the abdomen; finally, its hind tarsi are drawn out of the skin, and in a moment or two more the young locust frees itself and walks actively off, sometimes, however, with the cast skin adhering to the end of the abdomen.

Before the molting of the amnion, the body and legs are soft and flabby; immediately after, the young locust walks firmly on its legs, and even hops with agility. As we have shown on p. 229, in describing the later stages of the hatching process, the amnion is not shed till the young animal reaches the surface.

CHAPTER X.

METAMORPHOSES.

THE SIX STAGES OF GROWTH.

We have already seen (p. 237) that the Rocky Mountain locust requires on an average, about seven weeks, from the time of hatching, to attain full growth. Belonging to an Order in which the transformations are incomplete, the young locust differs but little in general structure from its parent. The most striking differences are the want of wings, and the less flattened, narrower prothorax, which rises from the sides more in the shape of a roof. The abdomen is also more roof-shaped. The perfect winged

FIG. 19.—ROCKY MOUNTAIN LOCUST.—*a*, *a*, newly-hatched larvæ; *b*, full-grown larva; *c*, pupa. (After Riley.)

[49] Mr. Riley is of the opinion (see his "Locust Plague in the United States") that in cases where there is requisite heat to insure development, but insufficient moisture to weaken the egg-shell, the terminal spines of the hind tibiæ and the tips of the mandibles may assist in rupturing the shell. To use his own words: "Ordinarily all these parts are sheathed in the delicate pellicle (*amnion*). But just in proportion as the hatching is retarded for want of moisture, after the embryon is once fully developed, in that proportion the jaws and spines harden; and it would seem that by the muscular contractions and expansions of hatching, which bring the ventral parts with great pressure against the shell, there might be slight friction of the horny points which would wear through the delicate *amnion* and facilitate the rupture of the shell." He was led to this opinion by having a number of eggs hatch where they had been kept perfectly dry for three months, and by noticing in many cases a transverse rupture at the points in contact with the horny parts mentioned. Ordinarily this action of the spines and jaws does not take place, since the spines at the hatching period are soft, and it cannot be considered as at all proved, even in the exceptional instances stated.

form is gradually assumed through a series of five molts, at the first four of which the wing-pads become more and more apparent, and at the last of which, from the pupa (Fig. 19, *c*) to the perfect state, the thorax becomes flattened, full wings are acquired, and the insect ceases to grow, except as the female abdomen becomes gravid and heavy with eggs. Yet with each molt, aside from the colorational changes, certain minute and less striking structural changes invariably take place, by observing which we may always know the comparative age and the particular stage of growth of any individual. These stages are well illustrated in Plate I, and we will briefly indicate the more minute structural differences in each:

First stage (Pl. I, Fig. 1).—This, which may be called the first larval stage, is characterized by the speckled gray coloring, the proportionally large head, and by the antennæ, which are short and thick, having from 12 to 13 joints, never more; the last number the most frequent, and joints 4, 5, 6, and last shorter than the others. The meso- and metanotum are subequal in length and together nearly as long as the pronotum. Average length 4.3mm.

Second stage (Pl. I, Fig. 2).—With the first molt, the general color darkens; the black marks intensify and the face becomes pitchy-black. There is often a conspicuous pale stripe along the middle of the ridged back. The antennæ are 16-jointed, the 6th, 7th, 8th, and 9th joints of the preceding stage dividing toward base. The pronotum extends more or less over the mesonotum, so as to be longer than this last and the metanotum together, and the lower edges of these two are full and rounded, giving the first indication of wing-pads. This may be called the second larval stage. Average length 6.8mm.

Third stage (Pl. I, Fig. 3).—With the second molt we get the third larval stage, in which the pale and dark colors still more strongly contrast and the face becomes still more pitchy. The pronotum entirely covers the mesonotum and not unfrequently a part of the metanotum; while the lower edges of these are subacutely produced into true wing-pads, the front one but slightly narrower than the hind one. The antennæ are still 16-jointed but with the joints more equal in length. This may be termed the third larval stage. Average length 9mm.

Fourth stage (Pl. I, Fig. 4).—With the third molt the pronotum, instead of having a straight transverse border, is much produced behind and now entirely covers and hides the other notal joints. The wing-pads, instead of extending downward, are turned up, so that their upper ends meet on the narrow back; the hind pair triangular, with a pale disc, and partly overlapping the front pair, which are narrower and longer but do not extend so far; the bases of both being hidden by the pronotum. Antennæ with 19 or 20 subequal joints. Average length 14mm. This may be known as the first pupal stage.

Fifth stage (Pl. I, Fig. 5).—With the fourth molt the pronotum is still more produced behind, and the wing-pads, though retaining the same positions, are as long as the pronotum, the front pair more hidden by the hind pair but extending nearly as far. The antennæ have 22 joints. Average length 17mm. This is the true or second pupal stage.

Sixth stage (Pl. I, Fig. 6).—The perfect winged insect, defined in Chapter I. The antennæ have from 23 to 26 joints, those of the ♀ generally one more than those of the ♂.

European authors differ as to whether there are three, four, or five molts in the European migratory species;[50] but we have watched *spretus* from the egg to the imago, and thousands of mounted and alcoholic specimens of all ages show the stages enumerated. The transition from the second to the third, however, is sometimes not very marked, and it is not improbable that, as is the case with many other insects, the number of molts may vary according to the amount of nutrition and rapidity of development.

The sexual characters are not well marked, and the sexes are consequently with difficulty distinguished, in the first three stages. In the

[50] See Köppen, "Ueber die Heuschrecken in Südrussland," 1862, pp. 22, 23.

first pupal stage the differences become apparent, and in the true pupa the parts are sufficiently well formed to permit coition, which, as we have had evidence, exceptionally takes place thus prematurely.

In giving measurements of the different stages we have taken as near as possible the period of growth between each stage. The depth of coloring varies greatly in the immature stages, and the pale mediodorsal line, so conspicuous on some of the larvæ, is entirely wanting in others. The ground-color after the first stage varies from pale-yellowish-gray, the common and typical color, to orange-brown, and even black, and from pale yellow to pure green. A marked green variety (var. *viridis* Riley) occurs, in which the normal pale yellowish-gray parts are bright green, the green being first distinctly noticeable in the third larval stage and enduring to maturity. We have never seen this green variety among the fresh arrivals from the mountain regions, but it is conspicuous among its brown companions when hatching in the Temporary region, and constitutes ordinarily about one in a thousand, though sometimes a much larger proportion, of the progeny of invading swarms.

THE PROCESS OF MOLTING.

Like all creatures which suffer exuviation or the shedding of skin, our locust quits feeding for a while and remains quiet during the process. The first three or larval skins are almost invariably shed on or near the ground, the young insects congregating under grass in little hollows or depressions, or under any shelter that offers for the purpose. The cast-off exuviæ are often very abundant in such sheltered places, and are not infrequently mistaken for dead locusts. The last two or pupal molts, on the contrary, more often take place above ground, the insects at these stages of growth preferring to fasten to some elevated object. Immediately after each molt the whole body is soft and colorless, as it was immediately after hatching.

In order to illustrate the interesting process of molting, we will trace an individual through the last molt—from the pupa to the winged insect—as it is the most difficult and, on account of the larger size of the animal, most easily watched. The other molts are very similar in mode of execution.

"When about to acquire wings the pupa crawls up some post, weed, grass stalk, or other object, and clutches such object securely with the hind feet, which are drawn up under the body. In doing so the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennæ drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing-pads, is noticed to swell. Presently the skin along this swollen portion splits right along the middle of the head and thorax, starting by a transverse, curved suture between the eyes, and ending at the base of the abdomen.

"Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of Fig. 20, *a*. As soon as the skin is split, the soft and white fore body and head swell and gradually extrude more and more by a series of muscular contortions; the new head slowly emerges from the old skin, which, with its empty eyes, is worked back beneath, and the new feelers and legs are being drawn from their casings and the future wings from their sheaths. At the end of six or seven minutes our locust—no longer pupa and not yet

FIG. 20.—ROCKY MOUNTAIN LOCUST.—Process of acquiring wings; *a*, pupa with skin just split on the back; *b*, the imago extruding; *c*, the imago nearly out; *d*, the imago with wings expanded; *e*, the imago with all parts perfect. (After Riley.)

imago—looks as in Fig. 20, *b*, the four front pupa-legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor—of swelling and contracting—with an occasional brief respite, the antennæ and the four front legs are freed, and the fulled and crimped wings extricated. The soft front legs rapidly stiffen, and, holding to its support as well as may be with these, the nascent locust employs whatever muscular force it is capable of to draw out the end of the abdomen and its long hind legs (Fig. 20, *c*). This in a few more minutes it finally does and with gait as unsteady as that of a new-dropped colt, it turns round and clambers up the side of the shrunken, cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength—the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are at first rolled longitudinally to a point, and as they expand and unroll, the hind wings, which are tucked and gathered along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (Fig. 20, *d*). From this point on the broad hind wings begin to fold up like fans beneath the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents

an aspect fresh and bright (Fig. 20, *e*). If now we examine the cast-off skin, we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not witnessed the operation to divine how the now stiff hind shanks of the mature insect had been extricated from the bent skeleton left behind. They were in fact drawn over the bent knee-joint, so that during the process they were doubled throughout their length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

"The molting, from the bursting of the pupa-skin to the full adjustment of the wings and straightening of the legs of the perfect insect, occupies less than three-quarters of an hour, and sometimes but half an hour. It takes place most frequently during the warmer part of the morning, and within an hour after the wings are once in position the parts have become sufficiently dry and stiffened to enable the insect to move about with ease; and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws. The molting period, especially the last, is a very critical one, and during the helplessness that belongs to it the unfortunate locust falls a prey to many enemies which otherwise would not molest it, and not infrequently to the voracity of the more active individuals of its own species."

DIFFERENCES IN THE IMMATURE STAGES BETWEEN THE ROCKY MOUNTAIN, THE LESSER, AND THE RED-LEGGED LOCUSTS.

The imaginal differences which characterize these three common and allied species, so often confounded with each other, have been given in Chapter I. In this connection, we will indicate those differences which will permit the separation of the three species in the earlier or immature stages. *Spretus*, though palest when mature, has the most black in the immature stages, and its black face is quite characteristic. One who has great familiarity with these three species in life can distinguish them at any stage (they all three go through the same number of molts), and can even distinguish between the exuviæ, those of *spretus* being darkest, those of *atlanis* most gray and uniformly speckled, and those of *femur-rubrum* palest, with the black streaks more strongly contrasting.

Spretus.—In the first stage, *spretus* has a decidedly ferocious look, the head being proportionally larger than in the other species. The colors are brown, gray, and dull white, the general tint being light gray, and the insect presenting a mottled and speckled appearance. Of the dark dots and marks, the most conspicuous and presistent (for some specimens are much darker than others) are, one behind the eyes, a subquadrate one on the side of the metathorax, a crescent streak on the sides of the swollen end of the hind femora, and two spots on the bulbous base of the hind tibiæ. In the second stage the face, with very rare exceptions, is pitchy black, the top of the head showing the three characteristic rows of transverse black marks on a rust-brown ground, the outer rows curving around the eyes, and the middle one broadest, and divided by a narrow medial pale line; the rust-brown color continues, with more irregular black marks, on the prothorax, narrowing toward its middle; on each side of it the anterior part of the prothorax is black, relieved below by a conspicuous, arched pale line, and this again with a more or less distinct dark lateral mark beneath. The

cheeks are mottled with rust-brown and edged behind with yellow; the head beneath and palpi, except a black rim around tips, are pale yellowish. The other colors are much as in the mature insects. With each succeeding stage the broad and pale streaks of prothorax intensify, and as soon as the hind wing-pads are turned up over the front pair, viz, in the fourth stage, the pale spot at the base, which becomes so conspicuous in the pupa, is visible. The black face after the first molt is quite characteristic, and often endures to the pupa state. (See Pl. I.)

Atlanis.—Aside from its smaller size, throughout its growth, this species may be distinguished as follows: In the first stage it is more uniformly and distinctly dotted with black, the legs being strongly dotted and banded, and the hind thighs being darker and showing much more distinctly the pale transverse streaks. In the second stage, the color is more livid or rosy, with a more strongly contrasting yellow venter. In the subsequent stages, these colorational differences still prevail, and the face is not black as in *spretus;* the pale spot on the hind wing-pads is less conspicuous in the fourth stage, and the pupa is distinguished not only by its smaller size and different color, but by the narrower, more obsolete black marks of the prothorax and by the wing-pads being considerably shorter and smaller, the hind pair livid, with only rarely a touch of black at base, and with the pale spot subobsolete. The pale streaks on the outside of the hind thighs are always conspicuous. It presents, in fact, a marked contrast to the pupa of *spretus. Atlanis* invariably has a pale face—yellow or greenish, speckled with gray-brown; and, just as invariably, the outside of the hind thighs more mottled with pale oblique streaks through the black. (See Pl. III.)

Femur-rubrum.—In size, intermediate between the other two, this species is nevertheless easily distinguished from either. In the first stage, the spots of body and bands of legs are subobsolete, and the hind thighs have no transverse streaks. In the subsequent stages, it is distinguished by the generally paler and greener hue; by the black being more solid and intense and contrasting more with the pale colors; by the wing-pads having no pale spot (or very rarely a faint indication of it), and by the outer black mark on hind thighs showing no pale streaks. The face is pale throughout and less speckled than in *atlanis*, and the upper white mark running from the side of the prothorax is more conspicuous on the head behind the eyes than in the other species. (See Pl. II.)

CHAPTER XI.

INVERTEBRATE ENEMIES.

THEIR VALUE.

The good offices of the larger vertebrate animals, in assisting man to overcome the devastations of the Rocky Mountain locust, will be set forth in the succeeding chapter. Under the present head we shall confine our attention to those smaller animals, belonging principally to its own Class, which, though often invisible or scarcely perceptible, yet carry on their good work most effectually. It is a law in nature that every animal necessarily meets with checks of one kind or another to its undue multiplication. Even the slowest-breeding species would soon overrun all habitable parts of the globe to the exclusion of others, were the counteracting influences—the struggle between species for supremacy—that keep it within bounds, by any possible means removed; while the more prolific species would do so in an almost incredibly short space of time. Most plant-feeding insects are so prolific that, unchecked, they would very soon annihilate the particular plants upon which they feed, and we find them beset with many checks, not the least important of which are their insect parasites and devourers. Let the plant-feeder once become unduly multiplied, and these, its natural enemies, invariably multiply in increasing proportion, until, in their turn, they get the upper hand, and

bring about a natural balance. It is because of the great fecundity of insects, whether phytophagous or carnivorous, that there often occur such comparatively sudden changes from excess to scarcity. A particular plant-feeder will swarm to an alarming and injurious extent one year and be scarcely heard of the next. The locust shares with other species in this particular. A period of excess is sure to be followed by a period of scarcity, due largely to the increase of its natural enemies. This was very fully illustrated last year; for on all sides the abundance of these natural enemies was observed. Not to speak now of birds and other larger enemies, it was matter of common remark in Minnesota that in many localities where the locust eggs were laid in unusually great numbers, the hatching the following spring was nothing like so extensive as was anticipated, on account of the destruction occasioned by grubs, mites, &c. From every State and Territory where eggs were thickly deposited, similar experience has been obtained. The locusts, after hatching, were attacked to an unusual extent by the various enemies to be presently enumerated, while careful observers in British America had already noticed, in 1876, that the locusts which occurred there were so loaded with parasites that they died without laying eggs; and the immunity from locust injury enjoyed there in 1877 is attributed largely to this cause.

It has been our privilege to watch quite closely the working of these more minute locust enemies during the past few years, and their usefulness is altogether underrated, for the simple reason that their work too often goes on hidden and unobserved. Considering the great abundance in which they sometimes occur, and their great assistance in keeping our Rocky Mountain locust in check, it is surprising how little is said of or attributed to insect enemies of the European migratory locusts by European writers. Gerstäcker, speaking of *migratoria*, says that it has no insect enemy worthy of mention, and cites only field crickets, a large locust (*Locusta viridissima*, L.), a Mantis, and the hair-worms. Köppen adds ants and a ground-beetle (*Calosoma*); but it is plain that neither of these late writers have had much personal experience in the matter.

The invertebrate enemies of our locust may, to facilitate reference, be divided into, 1st, those which affect the eggs; 2d, those which affect the active locust.

ANIMALS THAT DESTROY THE EGGS.

The Anthomyia Egg-parasite (*Anthomyia angustifrons*, Meigen, Fig. 21).—This is, perhaps, the most common and wide-spread of all the different egg-enemies, and in the fall of 1876 it destroyed on an average about ten per cent. of the eggs in Missouri, Kansas, and Nebraska, and in some localities a much larger percentage. It was also quite common in Iowa and Minnesota, and, as we learned during the past year, occurs in Colorado and Texas. It is doubtless this species which our correspondents in many cases refer to by the general term of "grubs," "white

worms," &c., as the cause of the non-hatching of eggs (App. 18), and the following extracts have reference to the work of the same:

Recently a white worm or maggot has been discovered in the locust eggs laid in this vicinity, and so general are the grubs that we really look for a great diminution in next year's locust crop. About the time the 'hoppers began laying eggs we had a hard, soaking rain, and since then we have had several more—the last this morning. By this time the ground is well soaked with water and the eggs were and are laid in earth that is quite moist. It is about two weeks since the 'hoppers first reached Mankato; they have laid many eggs, and already this worm or maggot has developed and seems to be on the increase, being found in the egg cells, where it sucks or destroys the egg. Some cells that I have opened have had two and three worms in them.—[J. C. Wise, Mankato, Minn., August 20, 1876.

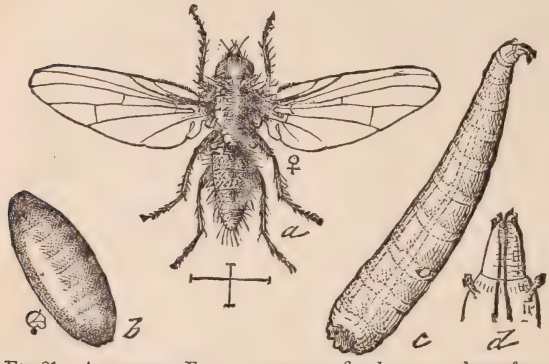

FIG. 21.—ANTHOMYIA EGG-PARASITE.—*a*, fly; *b*, pupa; *c*, larva from side; *d*, head of same from above—all enlarged. (After Riley.)

On the 9th I sent you a box of locust-egg parasites, and to-day I will send you some more of different sorts or different stages of development, or both. I find them more plentiful to-day than before. The ground seems to be full of them, from five to twenty of the small white worms in a single cell, one generally, though sometimes two, of the large white ones in a cell. The reddish-colored ones, I suppose, are in a different stage of development, though the same parasite. In every cell in which I have found any of those sent you, the eggs were nearly or quite destroyed. But there is another and a far more destructive enemy, viz, the hot sun, which is hatching them out by the million, though the parasites may continue their work after it ceases to operate. I shall be happy to do all I can to aid you in your investigations.—[C. E. Treadwell, Rockport, Atchison County, October 16, 1876.

Yesterday we discovered on a warm southern exposure that our locust eggs were hatching out maggots. We break open the cocoons, and the eggs on exposure to the sun for a few moments crawl away a worm. In warm places along the hedges the earth is alive with them. Is this a new development of the locust question? It would seem to be a confirmation of the theory you promulgated, as I understood it at the time. I secured a few of the perfect cocoons, which I inclose for your examination. We suppose these will do as the others do upon exposure to the sun.

The people here are quite excited over the matter, hoping it may be a solution of the problem for next year, at least, and have deputed me to lay the matter before you. Any information you can give us in regard to this, our latest, development will be thankfully received and acknowledged.—[S. M. Pratt, M. D., Hiawatha, Brown County, Kansas, October 30, 1876.

Various reports have been circulated in regard to the destruction of the eggs of the Rocky Mountain locust (*Caloptenus spretus*) by a worm. I am happy to state that these reports were substantiated yesterday by Mr. McLockhead, of Deer Creek, Kanawaka, twelve miles west of this city, who brought me a box of earth in which the eggs of the "hopper" had been abundantly deposited. To-day a similar box was secured from W. B. Barnett, esq., of Hiawatha, Brown County. In both of these instances a large proportion of the eggs have been destroyed by a small, white larva. Many of the egg-cases, which ordinarily each contain from twenty to thirty eggs, had

no eggs in them, but were full of these worms or larvæ, each one of which took the place of an egg which it had destroyed. Some of the egg-cases contained only two or three larvæ with more than twenty sound eggs.—[Prof. F. H. Snow, in Lawrence (Kansas) *Journal*, November 1, 1876.

I have just returned from quite an extensive trip to the Upper Minnesota. I send by mail a few larvæ and pupæ, in two little paste-board boxes, of Anthomyia, I presume. I found them thick in a strip of rich, black soil, where the hatching was suddenly arrested by a heavy rain on the 20th; and as the ground was low, the water stood there for several hours. On digging, I found plenty of cases where the 'hoppers had emerged from the shell (but not from the skin), and had stopped there, apparently, without strength to go any farther; but on digging them up and letting them stand in the sun for a few minutes, they came out all right. The larvæ that I send were very thick in these nests, sometimes half a dozen in one nest, and had eaten many of them out clean.—[Allen Whitman, Saint Paul, Minnesota, May 30, 1877.

Large numbers of the flies and of the worms were reported in different parts of Kansas last spring by our special assistants, and we never dug for five minutes among the locust eggs, anywhere in our travels during the month of May, without finding this parasite in various stages of development. Yet previous to 1876 no such enemy of these eggs had ever been recorded.

"This good little friend, which simultaneously prevailed over so large an extent of country, is a small white maggot (Fig. 21, *c*) of the same general form of the common meat maggots or 'gentles,' but measuring, when full grown and extended, not quite one-fourth of an inch in length. The head, with some of the anterior joints of the body, tapers and is retractile, and the jaws consist of two small hooks joined to a V-shaped, black, horny piece, which, as it is retracted or extended, plays beneath the transparent skin. The hind or tail end is squarely docked off, and contains two small yellowish-brown, eye-like spots, which are the principal spiracles or breathing pores.

"These small maggots are found in the locust-egg-pods, either singly or in varying numbers, there sometimes being a dozen packed together in the same pod. They exhaust the juices of the eggs, and leave nothing but the dry and discolored shells; and where they are not numerous enough to destroy all the eggs in the pod, their work, in breaking open a few, often causes all the others to rot."

When full grown, this maggot contracts into a stiff, cylindrical puparium, rounded at both ends, and of various shades of brown in color (Fig. 21, *b*). Within this hardened case the true pupa is formed, and "in the course of a week in warm weather, and longer as the weather is colder, there issues a small, grayish, two-winged fly (Fig. 21, *a*), about one-fourth of an inch long, the wings expanding about one-half of an inch, and in general appearance resembling a diminutive house-fly, except that the body is more slender and more tapering behind, and the wings relatively more ample. More carefully examined, the body is seen to be of an ash-gray color, tinged with rust-yellow, and beset with stiff, bristle-like hairs, those on the thorax stoutest, and those on the abdomen smaller but more uniformly distributed. The wings are faintly

smoky and iridescent. There are three dusky longitudinal stripes on the thorax, most distinct anteriorly, and another along the middle of the abdomen, most distinct in the male, which also differs from the female in the larger eyes, which meet much more closely on the top of the head than in the female, and in the face being whiter."

The species passes the winter mostly in the pupa state, though doubtless also to some extent in the perfect state. It may be found in all stages of growth during the autumn months until just before winter sets in, and again during the spring months.

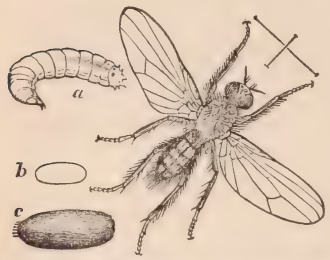

FIG. 22.—ANTHOMYIA RADICUM.—*a*, larva; *b*, pupa; fly to right. (After Curtis.)

"The flies of this genus are characterized by the shortness of the antennæ, and by the attenuated abdomen. The characters given to it are, however, by no means uniform, and as the species generally bear a very close resemblance to each other, and there have been a large number described in Europe (many of them very imperfectly), it becomes almost an impossibility to properly determine them. As the sexes often differ materially, it is also, except where they are reared from the larva, difficult to connect them; and as the colors often become sordid and dull in the cabinet, many of the described species have no real existence."

The flies frequent flowers, and often congregate and play in swarms in the air. Their eggs are white, smooth, oval, about 0.04 inch long, and are dropped near the food of the larva. In the larva state, these insects mostly feed on leguminous plants, and the carnivorous habit is exceptional. The species affecting the Cabbage, the Onion, the Radish, &c., have received different names, as *brassicæ*, *ceparum*, *raphani*, &c., but it is doubtful whether they are all good species. The egg-feeding species under consideration was originally described by Mr. Riley as a variety (*calopteni*) of *A. radicum*, L.; but through the kindness of Mr. R. H. Meade, of Bradford, England, who has paid especial attention to the genus, and who has examined specimens we sent him, we learn that it is the *A. angustifrons* of Meigen.[51] Compared with *A. radicum* (Fig. 22) the epistoma is less prominent, the abdomen narrower and not so distinctly marked with black along the middle and, transversely, at the sutures; while the male has, along the whole length of the inner or anterior sides of the hind tibiæ, a characteristic row of fine, rigid hairs, of even length, like a fine comb.

ANTHOMYIA ANGUSTIFRONS, Meigen.—*Egg.*—Oval, smooth, white, 0.04 inch long. *Larva.*—Skin unarmed, 0.24 inch long when extended, of the normal form, the mandibular hooks black, quite conspicuous, and diverging at base. Prothoracic spiracles elongate. Anal spiracles minute, yellowish-brown, with the 8 fleshy surrounding tubercles, small.

[51] It is the *Aricia fuscipes*, Zett., and belongs to the subgenus *Chortophila*, Macquart.

Pupa.—Pale-brown, rounded at each end, with the prothoracic spiracles and lips anteriorly, and the anal spiracles and lower tubercles posteriorly, showing as minute points.

Imago, ♀.—Average expanse 0.48 inch. General color ash-gray with a ferruginous hue, especially above, and a more or less intense metallic reflection. Face with white reflections below; eyes smooth, brown, encircled by the ground color, and this behind and on forehead bordered by a brown line; 2 similar lines at back of head from upper corners of eyes and approaching to neck; forehead dusky-brown, becoming bright yellowish-red toward base of antennæ, and the brown forking at right angles around occiput. Trophi and antennæ black, the style simple and somewhat longer than the whole antennæ. Thorax with three dusky longitudinal lines, obsolete behind; legs black, with cinereous hue beneath; wings faintly smoky, with brown-black veins, the discal cross-vein straight and transverse, the outer one bent and more oblique; balancers crumpled, yellowish. Abdomen with faint dusky medio-dorsal spots, broad at base, tapering and obsolescing toward end of each joint.

In the ♂, aside from the larger eyes, stronger bristles, and narrower, less tapering abdomen with its additional joint—all characteristic of the sex—the face is whiter, and the medio-dorsal dark mark of abdomen continuous, and the hind tibiæ are armed on the inner side with a pectinate series of fine hairs.

Described from 25 specimens of both sexes, reared from locust-egg-feeding larvæ.

The Common Flesh-fly (*Sarcophaga carnaria*, L.).—The red-tailed variety (*sarraceniæ*) of this ubiquitous insect, described and figured further on as preying on the locust, also attacks its eggs. It is a larger maggot than the preceding, and contracts to a darker pupa, which is not similarly rounded at each end, but has the hind end truncate, and the front end tapering. It sucks the eggs, as does the Anthomyia larva, but the parent fly is probably attracted principally to those which are addled or injured, as the pods in which we have found it have very generally been in a fluid state of decay.

Ground-beetles and their larvæ.—That many ground-beetles (*Carabidæ*) feed upon the eggs as well as upon the locusts there can be no doubt whatever, though few instances have been observed. One species, however, the *Agonoderes dorsalis*,[52] Lec. (Fig. 23), has been observed to settle in swarms in fields containing locust-eggs, and to busy itself devouring them. The following letter from Mr. W. Robertson, of Claytonville, Kans., under date of April 28, 1877, refers to this little beetle, which will be easily recognized from the figure, the colors being yellowish-brown and black:

FIG. 23.—AGONODERES DORSALIS. (Emerton, *del.*)

> On Sunday afternoon, April 15, the air was laden with those beetles; they came with a warm northwest wind, and I observed that they disappeared under the surface as soon as they fell.
>
> A few days afterward I went into a field that was plowed last fall for wheat, and abandoned because of the immense number of eggs it contained. I scratched a handful of earth to search for eggs, and found more than a dozen of these little beetles. I examined this field very closely, but found no beetles where I found no eggs. I also examined other fields and found the same result. I went to that same field again to-day, and found only very few eggs, and those few broken and half consumed. I could scarcely find a whole cocoon; the beetles are only where the eggs are, and in walking over the ground you rarely see one.

HARPALUS (?) LARVA.—While few of the perfect ground-beetles have been observed preying on locust-eggs, two larvæ were quite commonly

[52] Supposed to be the *Carabus comma* of Fabr.

found at this work in 1876. One of these (Fig. 24, *a*) is evidently the larva of some species of *Harpalus*, and probably of *H. herbivagus* Say, which is quite common in the locust regions. It was described in 1876.[53] It is an active creature, with powerful head and jaws, which, together with the prothorax, are light brown, the rest of the body being pale, and gradually tapering to the end, which is furnished with a stout anal proleg and two 4-jointed appendages. We have failed in our efforts to rear this larva to the perfect state, and can give but a more detailed description of it for the scientific reader.

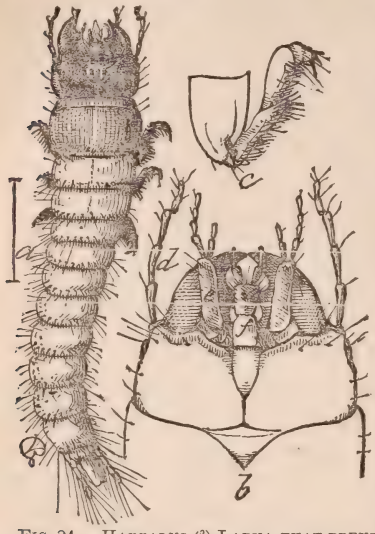

FIG. 24.—HARPALUS (?) LARVA THAT PREYS ON LOCUST EGGS.—*a*, larva from above; *b*, head, from beneath; *c*, leg—enlarged. (After Riley.)

Color, yellowish-white; prothorax and head highly polished yellowish-brown; the jaws darker. Head broad, depressed, and rugose in front; jaws broad, robust, dark, and with but one strong middle tooth; antennæ 5-jointed, joints 4 and 5 scarcely equaling 3 in length; maxillæ elongate, subcylindrical, with a 4-jointed outer and a 2-jointed inner palpus; mentum elongate, its base sheltered with the lower head; labrum also elongate and with 2-jointed palpi; all trophi armed with stiff hair. Prothoracic joint swollen, wider than head, twice as long as succeeding joint, horny, and with a darker anterior border, limited by a transverse stria posteriorly, and marked with fine longitudinal striæ. Legs, except coxæ, dark brown and thickly beset with short, spinous bristles of the same color. Abdomen tapering to end, with no horny plates, but each joint with two transverse rows of stiff yellowish hairs, the posterior rows strongest. Stigmata lateral, pale, the first pair on an anterior mesothoracic fold. Anal proleg stout, the cerci 4-jointed (joints 3 and 4 small and imperfectly separated) and reaching but little beyond it; eyes small, dark, and just behind base of antennæ. Length of largest specimens 0.58 inch.

Many specimens feeding on eggs of *Caloptenus spretus*.

THE EGG-FEEDING AMARA (*Amara obesa* Say[54]).—Another larva of about the same size, and belonging to the same family as the preceding, was also found, in 1876, preying on the locust eggs. It may easily be distinguished from the other by a series of broad, smoky or dark brown, horny plates along the back, and by somewhat paler horny pieces along the sides and beneath (Fig. 25, *a*). The prothorax is narrower, and the body bulges at the middle; the legs are pale, and the anal cerci are quite short. This plated larva was again found in large numbers, in

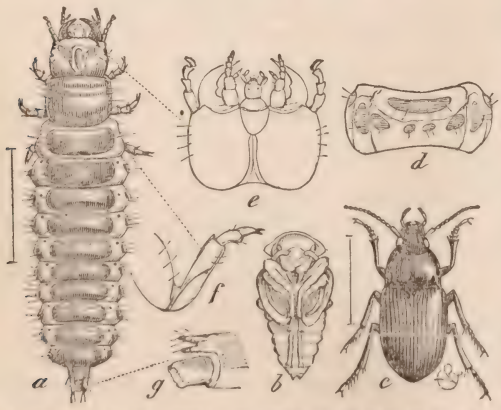

FIG. 25.—AMARA OBESA.—*a*, larva; *d*, under side of one of its middle joints; *e*, its head beneath; *f*, its leg; *g*, its anal cerci and proleg from side; *b*, pupa; *c*, beetle. (After Riley.)

[53] 9th Mo. Ent. Rep., p. 97, 1876. See, also, Packard's Rep. to Dr. Hayden, 1877, p. 662.

[54] Belongs to Zimmermann's subgenus *Celia*. He considers it the same as the European *patricia* Dej., but Chaudoir insists that it is different.

1877, preying on the locust eggs, especially in Minnesota; and the following letters from Mr. Seth H. Kenney, of Morriston, Rice County, Minnesota, through whose kindness we have been able to study all its transformations, have reference to it:

I herewith send you some grubs, such as have eaten large quantities of grasshopper eggs, and have extended all over our farms in this vicinity. I have found them eating the eggs, and where the eggs were laid most plentifully there the grubs are the thickest. I send you by mail two boxes, one full of soil, and quite a quantity of eggs and live grubs of all sizes, and some that have evidently begun to change into the beetle. The ground is dug and thrown to the surface by these grubs; and I send some of the soil as they throw it up, because it is singular. How they could become so plentiful, unless the eggs that make them are laid with the locust eggs, it is difficult to conceive. —[May 12, 1877.

The ground where these beetles occur is full of holes, from 4 to 6 inches deep, and just large enough to admit them. Now, I find no pellets near these holes, and I therefore conclude that the beetles do not make the pellets, but that the grubs do. I kept some beetles in a glass vessel with some grass over Sabbath, and when I examined them they had fought and devoured each other, until only one and the fragments of three were left.—[June 11, 1877.

The eggs must be laid during the summer months, and the larvæ which we have found of various sizes, but principally full grown, as late as November, must often hibernate and feed for awhile again in spring. In this, however, there will be found no regularity, and some of the more advanced larvæ doubtless produce beetles in the autumn, as the beetles of the genus are often found hibernating. The pupa (Fig. 25, *b*) is formed in a simple cavity in the ground, and lasts in midsummer from two to three weeks before changing to the beetle.

Authors differ as to the food-habits of the beetles of this genus, some believing these are phytophagous, others that they are carnivorous. The facts here recorded leave no doubt as to the carnivorous propensities of the species in question, and they are in accordance with the general habits of the family. It by no means follows, however, that the beetles may not at the same time be plant-feeders also, for we have good authority that a species (*Zabrus gibbus*, Fabr.), belonging to an allied genus, is at times quite injurious to wheat, while Mr. Zimmermann,[55] in a valuable memoir on the genus, shows that they feed upon the pith and stems of gramineæ and on succulent roots as well as on soft insects. Indeed, the two habits are much more often combined than entomologists generally admit.

The beetles of the genus generally hide during the day under stones, clods, grass, &c. The habit of the larvæ, noticed by Mr. Kenney, of throwing up little pellets of earth, is quite curious, and we can only account for it by the soil being unusually wet and adhering to different parts of the body, from which, in being detached, it gets rolled by the jaws into the pellets mentioned, which are irregular in shape and average about 1.5^{mm} in diameter.

AMARA OBESA.—*Larva.*—Color dull whitish; heaviest and widest about the middle of the body, tapering rather suddenly from joint 10; head, and prothorax above, gam-

[55] *Rev. Ent. de Silbermann*, II, p. 189.

boge-yellow. Joints 2–12 each with a dorsal transverse corneous plate of a somewhat deeper brownish-yellow; a medial impressed line on all the joints, and two distinct impressions each side of it on all the plates; a lateral substigmatal series of ovoid tubercular plates, and 7 ventral ones, on each abdominal joint, arranged as in Fig 25, *d*, varying in size so as either to be well separated or contiguous, those on joints 11 and 12 coalescing. Head flattened, depressed; mandibles moderately stout, with a small middle tooth; antennæ not reaching beyond mandibles, 4-jointed, the 3d bent inward, the 4th outward; maxilla with 2d joint slightly shorter than the basal, with tapering 4-jointed outer and 2-jointed inner palpi; mentum short; labium faintly bilobed, the terminal joint black; the palpi 2-jointed, the terminal joint small and bent inward; inside of 2d maxillary joint and tip of labium armed with setæ. Prothoracic joint rounded, faintly striate at front and hind borders; legs pale, with an X-shaped black mark at outside of coxæ, which are stout; trochanter very short from above; tarsus distinctly 2-clawed, and nearly as long as tibia; stigmata pale, lateral, the first pair on a fold on the front edge of the mesothorax; anal proleg horizontal, rather obliquely truncate beneath, not much longer than joint 12, the cerci not reaching beyond it, and faintly triarticulate, with the tip black. Average length, 14mm.

Pupa.—Unarmed, long, with the tips of tarsi broadly and distinctly bifid.

Described from many locust-egg-feeding specimens.

Other Carabid larvæ no doubt prey upon these eggs, since we have

FIG. 26.—HARPALUS? LARVA.—*B*, under side of head; *h*, *i*, *j*, under side of different joints of body. (After Riley.)

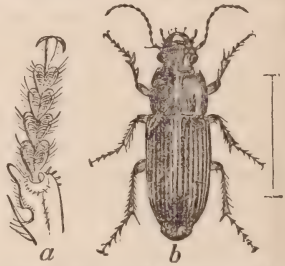

FIG. 27.—PENNSYLVANIA GROUND-BEETLE.—*a*, anterior tarsus and notched tibia; *b*, beetle. (After Riley.)

discovered two species, distinct from either of the above, feeding on the eggs of other locusts. We introduce the figure of a larger species (Fig. 26), and its probable parent, the Pennsylvania Ground-beetle (*Harpalus pennsylvanicus* De Geer, Fig. 27).

Blister-beetle larvæ.—Of all the different insects that feed on the eggs of our locust, these, though not the most common or effective in checking locust increase, are nevertheless the most interesting; first, because of the singular changes which they go through; secondly, because their larval habits remained so long unknown, notwithstanding the frequency with which the beetles themselves recur in great numbers on different plants. The habit of feeding on locust eggs in the larva state, though suspected by Mr. Riley in 1876, was first demonstrated by him in 1877. These blister-beetles are all elongate in form, and possess the property, in common with the Spanish-fly of the shops, of drawing blisters on the human flesh. Many of the species show great partiality to the Potato, and were for a long time considered the most formidable enemies of this esculent. The Striped blister-beetle (Fig. 30; Pl. IV, Fig. 10) is familiar to most farmers, in the more Southern States especially, and swarms at times on potato and tomato vines. The Ash-gray blister-beetle (Fig. 31, *a*) ranges farther north, and attacks (besides the Potato) the Honey-locust, various kinds of beans, lucerne, apple-trees, beets, &c. The Margined blister-beetle (Pl. IV, Fig. 11), aside from attacking potato and tomato vines, is often injurious to the egg-plant, the Kentucky coffee-tree (*Gymnocladus canadensis*), spinach, and other garden

plants. The Black blister-beetle (*Epicauta pennsylvanica* De Geer) is another common species, occurring late in the summer and in autumn on various wild plants, as *Solidago*, *Eupatorium*, &c.

All these beetles lay eggs in the ground in the vicinity of locust-eggs, and their young, at first slender, with long legs, and active, eat into the locust-egg mass (Pl. IV, Fig. 1, 2). Here they remain until they have devoured all or nearly all the locust-eggs, having changed, meanwhile, into clumsy, short-legged grubs (Pl. IV, Fig. 5). Now forsaking the remnants of the egg-mass, the grub penetrates the earth near by and changes to the coarctate larva (Pl. IV, Fig. 8), then to the pupa (Pl. IV, Fig. 9), and finally to the perfect beetle.

In a paper published last November in the Transactions of the Academy of Science of Saint Louis (vol. iii, pp. 544–565), Mr. Riley gave an extended account of the transformations and habits of some of these blister-beetles, together with the natural history of certain other genera in the same family, in order to show, by way of comparison, the differences in habit that are coupled with similarity of development. Though written more particularly for the entomologist, we shall reproduce the larger part of the paper as appropriate in this connection, adding a few facts, in brackets, ascertained since its publication; and omitting the detailed descriptions, which the scientific reader will find in the original paper.

In addition to the species mentioned in this paper we have, since its publication, found the triungulin of the Black Blister-beetle (*Epicauta pennsylvanica*) in the egg-mass of *spretus*, and have received, in the carabidoid stage, the larva of some other species from Mr. S. H. Scudder, taken ten years ago at Sudbury, Vt., in the egg-clusters of another locust (*Chloëaltis conspersa*, Harr.), a species which oviposits in dead wood that is rather soft, and sufficiently moist, drilling therein a cylindrical hole for the purpose, packing the eggs in the sawdust resulting, and capping the mass with a "black glutinous secretion, excessively hard, smooth, and shiny."[56] The fact that such eggs are also attacked by blister-beetle larvæ indicates how general the locust-egg-feeding habit is in such larvæ.

On the larval characters and habits of the Blister-beetles belonging to the genera *Macrobasis* Lec. and *Epicauta* Fabr., with remarks on other species of the family Meloïdæ.

[From the Transactions of the Ac. Sc. of St. Louis, vol. iii.]

The larval habits of the European Cantharis of commerce, as also those of its congeners in our own country and in other parts of the world, have hitherto remained a mystery, notwithstanding the frequency with which the beetles occur, their great abundance at times, and their commercial value and interest. The same remark holds true of the allied genera *Macrobasis*, *Epicauta*, and *Henous*, the species of which have the same valuable vesicatory properties as *Cantharis*. Some of these species are very com-

[56] A full account of the nidification of this species will be found in Mr. Scudder's "Distribution of Insects in New Hampshire." Final Rep. Geology of N. H., 1874, p. 372.

mon in the United States and quite injurious to vegetation, swarming at times on potato-vines, beans, clematis, and other plants. Their great numbers and destructive habits make it all the more remarkable that so little has hitherto been discovered of their early life. Harris, who evidently had hatched the first larva of the Ash-gray blister-beetle (*Macrobasis unicolor* Kirby), says: "The larvæ are slender, somewhat flattened grubs, of a yellowish color, banded with black, with a small reddish head and six legs. These grubs are very active in their motions, and appear to live upon fine roots in the ground; but I have not been able to keep them till they arrived at maturity, and therefore know nothing further of their history." ("Insects injurious to Vegetation", p. 138.) Latreille, according to Westwood, states that the larvæ live beneath the ground, feeding on the roots of vegetables (Introduction, vol. i, p. 301), but the statement is evidently founded on conjecture. Ratzeburg, who well describes the method of oviposition of the European *Cantharis vesicatoria*, and roughly figures the first larva (*Forst Insecten*, II, Col. Taf. ii, fig. 27 *B*), believed that it was a plant-feeder in the immature state. Olivier describes what is possibly the second larva, as a soft, yellowish-white, 13-jointed grub, with short, filiform antennæ, and short, corneous, thoracic legs—"living in earth" (*Traité Élém.*, etc., M. Girard, Col., p. 618); but his account is very loose, and may apply to any number of other coleopterous larvæ. Audouin, who studied the Cantharides intently, making them the subject of his thesis in his medical examination, was obliged to confess that absolutely nothing was known of their larval history. This is about all we learn from the older writers, and the opinion was general among them that, like their parents, the blister-beetle larvæ in question were vegetable feeders; and Mr. William Saunders, of London, Ont., in a paper on the same subject, read at the 1876 meeting of the American Pharmaceutical Society, could add nothing more definite.

In 1874, Laboulbène mentioned the fact (*Ann. Soc. Ent. de France*, 1874, lxxxiii), that some one (name not given) had seen the European *Cantharis vesicatoria* issuing from ground in the neighborhood of which there were wasps (*guêpes*—no specific reference given), and rashly concludes that the former were parasitic on these. Still more recently, M. J. Lichtenstein, of Montpellier, France, has endeavored to discover the larval habits of this species. He has succeeded, by furnishing the larvæ of *C. vesicatoria* with artificial nourishment composed of the filled stomachs of honey-making bees, and especially of *Ceratina*, in tracing the development from the triungulin to the coarctate larva, which last differs from those of the other species considered by me, in freeing itself entirely from the second larva skin. He has thus established the fact that *Cantharis* agrees with the other species of the family in its hyper-metamorphosis; but its natural habits remain as much as ever a mystery, though the indications are that it develops in the nests of some bee. These facts, as well as analogy, pointed to a parasitic life and partly carnivorous, partly melivorous diet for our own allied species, since the life-history of two genera in the family, viz, *Meloë* Linn. and *Sitaris* Latr. has been fully traced. Indeed the young of all vesicants belonging to the *Meloïdæ*, so far as anything has yet been known of them, develop in the cells of honey-making bees, first devouring the egg of the bee, and then appropriating the honey and bee-bread stored up by the same. They all are remarkable, in individual development, for passing through seven distinct stages, viz, the egg, the first larva or *triungulin*, the second larva, the coarctate larva or pseudopupa, the third larva, the true pupa, and the imago.

History of Meloë.

The history of *Meloë* may be briefly summed up as follows:—The newly hatched or first larva (now generally called *triungulin*) was first mentioned in 1700 by the Holland entomologist Gœdart, who hatched it from the egg. Frisch and Réaumur both mistook it for a louse peculiar to bees and flies. DeGeer, who also obtained it from the egg, mentions it in 1775 as a parasite of Hymenoptera. Linnæus called what is evidently the same thing, *Pediculus apis;* Kirby in 1802 described it as *Pediculus melittæ*, and Dufour in 1828 named it *Triungulinus andrenetarum*. Newport in 1845 (*Trans. Linn. Soc.*,

vol. xx, p. 297) first rightly concluded that it was carried into the nests of bees, and described, in addition, the full-grown larva from exuvial characters, and the coarctate larva and pupa which he found in the cells of *Anthophora retusa*. He failed, however, to fill the gap between the first and full-grown larva; and this Fabre first inferentially did in 1858 (*Ann. d. Sc. Nat.*, Zool., t. ix, p. 265) by tracing the analogous stages of *Sitaris*.

The female *Meloë* is very prolific. She lays at three or four different intervals, in loose irregular masses in the ground, and may produce from three to four thousand eggs. These are soft, whitish, cylindrical, and rounded at each end. They give birth to the triungulins, which, a few days after hatching—the number depending on the temperature—run actively about and climb on to Composite, Ranunculaceous, and other flowers, from which they attach themselves to bees and flies that visit the flowers. Fastening alike to many hairy Diptera and to Hymenoptera which can be of little or no service to them, many are doomed to perish, and only the few fortunate ones are carried to the proper cells of some *Anthophora*. Once in the cell, the triungulin falls upon the bee-egg, which it soon exhausts. A molt then takes place and the second larva is produced. Clumsy and with locomotive power reduced to a minimum, this second larva devours the thickened honey stored up for the bee-larva. It then changes to the pseudo-pupa with the skin of the second larva only partially shed; then to a third larva within the partially rent pseudo-pupal skin, and finally to the true pupa and imago. These different changes of form are known by the name of hypermetamorphoses, the term first given them by Fabre to distinguish them from the normal changes from larva to pupa and imago, experienced by insects generally. The triungulin or first larva (Fig. 28, *a*) is characterized by a prominent labrum, very stout thighs, unarmed shanks, three broad and subspatulate tarsal claws, feeble and reduced trophi, untoothed jaws, 3-jointed antennæ[57] ending in a long seta, and four anal setæ, the two inner ones longest. When the abdomen is shrunken the general aspect is very much that of *Pediculus*, and it is hardly surprising that some of the early describers so determined it.

FIG. 28.—MELOË.—*a*, first larva; *b*, claws; *c*, antenna; *d*, maxillary palpus; *e*, labial palpus; *f*, mandible; *g*, an abdominal joint; *h*, imago, ♀; *i*, antenna of ♂. (After Riley.)

HISTORY OF SITARIS.

The history of *Sitaris* is also well known and agrees very closely with that of *Meloë*. Its first larva was figured many years ago by Westwood (Introduction, &c., Fig. 34, 5)

[57] My figure is from specimens affecting the mature honey-bee at San Diego, Cal. It corresponds very closely with Newport's original figure and description of that of the European *M. cicatricosus*, and belongs doubtless to one of our Pacific coast species, probably *M. barbarus*, Lec. It is 2mm. long. The head is produced in front, with a strong labrum, beyond which the smooth jaws do not reach; the antennæ are 3-jointed, and similar to those of *cicatricosus*; the mouth-parts are diminutive, the maxillary palpus 3-jointed, the 3d joint longer than the others together and tipped with a few short, weak points; the labial palpus is two jointed; the coxæ are armed with a few very strong spines; the femora are very stout and faintly imbricated; the tibiæ are unarmed, and the tarsal claws subspatulate, the middle one pale, ½ longer and twice as broad as the two outer ones, which are dark, articulate, close together, and curve slightly outward. The first pair of stigmata are distinctly dorsal and on the mesothoracic joint. The dorsal hind border of the abdominal joints is armed with 8 spinous hairs, the 4 intermediate ones only half as long as the others. Newport is evidently wrong in considering the jaws articulate in themselves, while Candèze is wrong in describing the antennæ as 5-jointed (*Mem. de la Soc. Roy. des Sc.*, viii, p. 530, Liège, 1853). Packard's figure of what is in all probability *M. angusticollis* Say, fails to indicate the characteristic mesothoracic spiracles, and probably makes the two outer anal setæ too short—these anal appendices being in reality nothing more than prolonged spinous hairs, such as occur on the other joints. The form of the abdomen varies, contracting somewhat with age. Newport remarks on the similarity of the triungulins of *Meloë violaceus*, *M. proscarabæus*, and *M. cicatricosus* being so great that he could discover no differences. Judging from figures sent me by M. Lichtenstein, very slight differences occur in the relative length of the antennal joints, and none other.

from specimens obtained from Audouin, who found the female *Sitaris* in the cells of *Anthophora* inclosed in its thin pseudo-pupal and second larval skins, which Audouin erroneously took to be the pellicle of the devoured bee-larva. But the complete life history of the genus was first given by Fabre in 1857 (*Ann. d. Sc. Nat.*, Zool., t. vii, p. 299; t. ix, p. 265), who studied the *S. humeralis* Fabr., while that of *S. colletis* V.-M. has been more recently given by M. Valery-Mayet, of Montpellier, France (*Ann. Soc. Ent. de Fr.* 1875, p. 65), from whom I have specimens in all stages. The former species infests the nests of *Anthophora*, the latter those of *Colletes*. In the former the newly hatched larvæ hybernate in huddled masses in the galleries of the bee; in the latter they hybernate in the bee-cell, slowly feeding while the temperature permits; but such differences doubtless depend on the relative earliness in the autumn that the eggs are laid. The first larva or triungulin (Fig. 29, *a*) agrees very much in the head, tarsal and general characters, with that of *Meloë*, but differs in several important particulars, and especially in having a pair of pre-anal spinnerets, from which is secreted a serous sticky fluid, which aids the animal in holding firmly to the bee that is to carry it into the nest. A pre-anal pair of claspers also assists in this work.[58] The hypermetamorphoses are very similar to those of *Meloë*. The triungulin, after absorbing the contents of the bee-egg, molts, and thereafter floats upon and devours the honey—the pseudo-pupa, third larva, and true pupa all forming in due time within the second larval skin. The female does not feed, and on account of her heavy abdomen travels but a short distance from the bee-burrows where she developed.

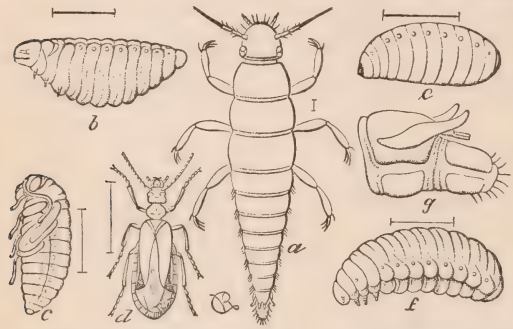

FIG. 29.—SITARIS.—*a*, first larva; *g*, anal spinnerets and clasps of same; *b*, second larva; *e*, pseudo-pupa; *f*, third larva; *c*, pupa; *d*, imago, ♀. (After V.-Mayet.)

HISTORY OF HORNIA.

While the natural history of none of our North American species of *Meloë* has been traced or recorded, they will, beyond all doubt, be found to agree with their European congeners in their partial parasitism on mason-bees. In examining the cells of *Anthophora abrupta*[59] Say, I have so far failed to discover that *Meloë* is parasitic upon that species, but *Meloë* is, in reality, very rare around Saint Louis. I have, however, found on four different occasions in the Fall, within the sealed cells of the bee mentioned, a very interesting and anomalous Meloïd (*Hornia minutipennis*, Riley), which may be taken to represent the typical partial parasitism of the family in the United States. There is a tendency in the family to wing-reduction, but in no hitherto described species is the reduction carried to such extremes as in this (Pl. IV, Fig. 13), both sexes having the elytra as rudimentary as in the ♀ of the well-known European glow-worm (*Lampyris noctiluca*). Another characteristic feature is its simple tarsal claws, which, together with the rudimentary wings and the heavy body, show it to be a degradational form. *Anthophora abrupta*, its host, builds mostly in steeply-inclined or perpendicular clay banks, and, in addition, extends a tube of clay from the entrance. The burrow has usually two branches which decline about an inch from the surface of the bank, and 6 or 8 cells are arranged end to end. By means of saliva the inside of the cell is ren-

[58] The small size (about 1mm long) and the hairless and spineless nature of this larva contrast strongly with the other triungulins considered in this paper. The tarsal claws are somewhat narrower than in *Meloë*, and unicolorous. A few soft lateral hairs are represented on the abdominal joints in the figure, but they are scarcely perceptible under the strongest microscope. Nor do any hairs or spines appear in any of the subsequent stages, even on the true pupa. The pseudo-pupa lacks the prominent lateral ridge so striking in the others. The stigmata are so faint in the triungulin that Mayet could not resolve them; but with proper light and specimens rendered transparent I have discerned them in the same positions as in *Meloë*. The mandibles are toothed.

[59] = *A. sponsa*, Smith.

dered impervious to the moisture of the honey and bee-bread stored in it for the young. It is evident, therefore, that this clumsy Meloïd will have difficulty in crawling out of or about the cells, and it is probably subterranean and seldom, if ever, leaves the bee-gallery. It can climb and drag its body, but with some difficulty, up a steep surface, and, as it does not leave the bee-cell till spring, when the *Anthophora* tubes are very generally broken and have fallen, it may possibly wander a short distance from the mouth of the bee-burrow. The triungulin is yet unknown, but the ultimate stage of the second larva as well as of the coarctate larva, as shown by the distended and unruptured skins, exhibits the ordinary family characteristics, the legs and mouth-parts being atrophied in the former, and merely tuberculous in the latter. The lateral ridge, as found in *Epicauta* and *Meloë*, is not conspicuous, and in this respect, as well as in the final transformations taking place within the two unrent skins, the insect approaches *Sitaris*. In the hairless and unarmed surface of the second larva, and of the third larva and pupa, as shown by careful examination of their shrunken exuviæ, the insect also resembles that genus.

[The male, which we have figured, is characterized by two series of subquadrate semi-corneous, dorsal abdominal plates which are lacking in the female. The beetle is fully formed in autumn, but remains within the distended larval exuviæ until the following spring, when it works out of them backwards. As warm weather approaches, both sexes become quite active, with a strong tendency to burrow whenever they get a chance. The abdomen of the male shrinks somewhat, while its surface hardens and becomes firmer. During the early part of May we have had one female lay, loosely in the ground, as many as 680 eggs. Over two weeks were occupied with the laying, and the abdomen steadily shrank until it was not more than one-third as large as in our figure of the male. The eggs are pale honey-yellow, ovoid, 1.1^{mm} long, and rather more than one-third as wide in the middle. The triungulin has not hatched at this writing, May 13th.]

HISTORY OF EPICAUTA.

It is generally stated by writers on the hive-bee that the Oil-beetle (*Meloë*) is one of its parasites. The possibility that our more common blister-beetles were similarly parasitic on bees, taken in connection with the frequent complaints from apiarians of the wholesale death of bees from causes little understood, led me, some years since, to pay attention to the biological characteristics of the blister-beetles, in the hope of ascertaining whether or not they really bear any connection with bee mortality. From these investigations I am satisfied that *Meloë* is only parasitic on the perfect hive-bee, as it is on so many other winged insects that frequent flowers, and that it cannot well, in the nature of the case, breed in the cells of any social bee whose young are fed by nurses in open cells.

I have had no difficulty in getting the eggs or the first larva of several of our vesicants, and described some of them at the Hartford (1874) meeting of the American Association for the Advancement of Science; but these young larvæ refused to climb on to plants furnished to them, or to fasten to bees or other hairy insects. Nor would they nourish upon honey, bee-bread, or bee larvæ on which they were placed. They showed a proclivity for burrowing in the ground, and acted quite differently from those of *Meloë* or *Sitaris*, which not only readily attach to bees in confinement, but which, in the case of *Meloë*, I have known to so crowd upon mature hive-bees as to worry them to death and cause extended loss in the apiary. Explorations into the nests of solitary bees gave no clew, and, in fact, the immense numbers in which the more common blister-beetles occur rendered a parasitic life upon such bees highly improbable. In sweeping plants and flowers with the net, I had never met with any of the first larvæ with which I had become familiar, as already indicated; while I had on several occasions, in digging ground where there was no trace of bee-nests, met with the curious pseudo-pupa so characteristic of the family. While analogy and the law of unity of habit in species of the same family pointed,

FIG. 30.—EPICAUTA VITTATA: normal form.

therefore, to a parasitic life, I began to conclude, from the facts just stated, that the parasitism was of another kind, having satisfied myself by various experiments that the triungulins did not feed on roots. Few discoveries are stumbled upon. We find as a rule that only which we anticipate or look for. Late last fall, in digging up the eggs of the Rocky Mountain locust (*Caloptenus spretus*) at Manhattan, Kans., the pseudopupæ were not unfrequently met with. The thought at once occurred to me that locust-eggs might be the proper food for these blister-beetle larvæ, and it was encouraged by the fact that the Meloïds abound most in those dry Western regions where the Acrididæ most prevail, and by a pretty distinct recollection, which my notes support, that the years when the vesicants were most injurious to potatoes had been preceded by dry falls, during which there had been much locust injury and, necessarily, unusual locust increase. The suspicion thus raised that these blister-beetles preyed in the preparatory states upon locust eggs was confirmed last spring by finding the larvæ of different ages within the egg-pods and devouring the eggs of *Caloptenus spretus*. Mr. A. N. Godfrey had, also, no difficulty, under my directions, in finding them last May at Manhattan; while they were sent to me among other locust-egg parasites by Mr. Seth H. Kenney of Morristown, Minn., and from Saint Peter's, in the same State, by Prof. Cyrus Thomas.

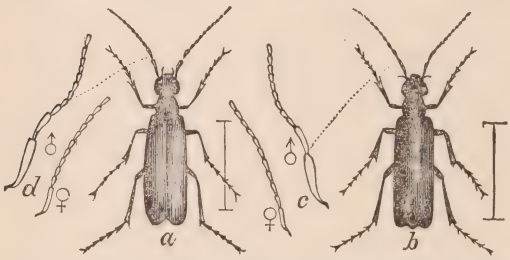

FIG. 31.—MACROBASIS UNICOLOR.—*a*, normal, gray form; *b*, black (*murina*) form; *c*, *d*, male and female antennæ of either. (After Riley.)

From such larvæ preying upon the eggs of *spretus* I have reared the unicolorous form of *Epicauta cinerea* (Forster), or the Margined blister-beetle;[60] the *Epicauta pennsylvanica* (DeGeer),[61] or the Black blister-beetle; the *Macrobasis unicolor* (Kirby),[62] or the Ash-gray blister-beetle; and the form of it described as *murina* by LeConte, or the Black-rat blister-beetle.

Since then I have found it very easy to trace the larval habits and development of the two more common potato-feeding species around Saint Louis, viz, the Striped blister-beetle (*Epicauta vittata* Fabr.)[63] and the Margined blister-beetle (*marginata* Fabr.) just alluded to.

Careful examination of locust-eggs in the vicinity of potato-fields frequented by these beetles shows a varying proportion of the egg-pods affected, and in some locations nearly every pod of the Differential Locust (*Caloptenus differentialis*) will contain the *Epicauta* larva. The eggs of this locust are laid in large masses of 70 to about 100. The pod is but slightly bent, rather compact outside, while the eggs are irregularly arranged, and capped with but a shallow covering of mucous matter. It is the egg-pod of this species which the larvæ of the two blister-beetles in question prefer; for

FIG. 32.—CALOPTENUS DIFFERENTIALIS. (After Riley.)

[60] The black, gray-margined form, very appropriately described by Fabricius as *marginata*, is referred to *cinerea* Forster by modern systematists, and specifically united with it by Dr. Horn. Yet the fact remains that the two are not ordinarily, if ever, found commingled. The margined form is very common in potato-fields in Missouri. It shows little variation and is found almost invariably in conjunction with *vittata*, but not with the unicolorous form in question, which is most common farther west and occurs abundantly without the margined form—all which is against the specific union of the two.

[61] = *atrata* Fabr.

[62] = *cinerea* Fabr., *Fabricii* Lec., *murina* Lec., *debilis* Lec. I accept Dr. Horn's conclusion that the last two are but poorly developed forms of this species. Yet the *murina* form is not due to rubbing or injury, but issues from the pupa without a trace of gray scales on the elytra.

[63] = *lemniscata* Fabr. Dr. Horn retains *lemniscata* as a distinct species in his Revision already referred to. The outer stripe in the bi-vittate specimens divides up in others so as to give the tri-vittate character on which *lemniscata* is founded. Both extremes and every possible variation between them occur constantly together in the same potato-field in Missouri, and there are no other differences of specific value.

while they will feed upon those of other species in confinement, I have so far found none in the deeper-necked, narrower, more compact egg-pods either of *Caloptenus femur-rubrum*, *C. atlanis*, or *Œdipoda sulphurea*, in which the eggs are regularly and quadrilinearly arranged as in those of *C. spretus*.

Not only have I found a large proportion of the egg-pods of *C. differentialis* naturally infested with these *Epicauta* larvæ, but I have succeeded in hatching and rearing numbers in-doors, and have them even at this writing (October 30), by hundreds, in all stages from the first larva to the pseudo-pupa. The larval habits of the genus may be illustrated by reciting those of one of the species, viz, *vittata*.

From July till the middle of October the eggs are being laid in the ground in loose, irregular masses of about 130 on an average—the female excavating a hole for the purpose, and afterward covering up the mass by scratching with her feet. In confinement she sometimes omits both these instinctive acts and oviposits on the surface of the ground. She lays at several different intervals, producing in the aggregate probably from four to five hundred ova, judging from examinations made on the ovaries of some that were gravid. She prefers for purposes of oviposition the very same warm sunny locations chosen by the locusts, and doubtless instinctively places her eggs near those of these last, as I have on several occasions found them in close proximity. In the course of about 10 days—more or less, according to the temperature of the ground—the first larva or triungulin hatches. The hatching takes place without the aid of any *ruptor ovi*, for the egg-shell is so delicate that it easily splits, from mere expansion, along the back near the head, and breaks and shrivels up with the escape of the larva. These little triungulins (Pl. IV, Fig. 2), at first feeble and perfectly white, soon assume their natural light brown color and commence to move about. At night or during cold or wet weather all those of a batch huddle together with little motion, but when warmed by the sun they become very active, running with their long legs over the ground, and prying with their large heads and strong jaws into every crease and crevice in the soil, into which, in due time, they burrow and hide. Under the microscope they are seen to fairly bristle with spinous hairs, which aid in burrowing. As becomes a carnivorous creature whose prey must be industriously sought, they display great power of endurance, and will survive for a fortnight without food in a moderate temperature. Yet in the search for locust-eggs many are, without doubt, doomed to perish, and only the more fortunate succeed in finding appropriate diet. Upon the slightest disturbance they curl up in a ball with the head bent pretty closely on the breast.

Reaching a locust egg-pod, our triungulin, by chance, or instinct, or both combined, commences to burrow through the mucous neck or covering, and makes its first repast thereon. If it has been long in the search, and its jaws are well hardened, it makes quick work through this porous and cellular matter, and at once gnaws away at an egg, first devouring a portion of the shell, and then, in the course of two or three days, sucking up the contents. Should two or more triungulins enter the same egg-pod, a deadly conflict sooner or later ensues until one alone remains the victorious possessor. By the time the contents of an egg are consumed, the body of the parasite has perceptibly increased so that the white sutures between the segmental plates show conspicuously, especially as there is a tendency on the part of the animal to curve its body, and bring the sutures more into relief. A second egg is attacked and more or less completely exhausted of its contents, when a period of rest ensues, the triungulin skin splits along the back and there issues the *Second Larva* (Pl. IV, Fig. 4)—white, soft, with reduced legs and quite different in general appearance from the first. This molt is experienced about the eighth day from the first taking of nourishment. The animal now naturally lies in a curved position (Pl. IV, Fig. 4, *d*), but if extracted from the egg-pod, will stretch itself and move with great activity, reminding one very strongly of many Carabid larvæ, for which reason I would designate this as the *Carabidoid* stage of the second larva. After feeding for about another week, a second molt takes place, the skin, as before, splitting along the back and the new larva hunching out of it until the

extremities are brought together and released almost simultaneously. This kind of molting, which is characteristic of our blister-beetles up to the pseudo-pupal state, is exceptional among insects, the skin being ordinarily worked backward from the head. The modification at this molt is slight. The mouth-parts and legs become rudimentary and the body takes on more fully the clumsy aspect of the typical Lamellicorn larva, for which reason I designate this as the *Scarabæidoid* stage of the second larva.

Another six or seven days elapse and the scarabæidoid skin is rent and shed with but slight modification in the form and characters of the animal.[64] In this, the *Ultimate* stage of the second larva (Pl. IV, Fig. 5), the creature grows apace, its head being constantly bathed in the rich juices of the locust-eggs, which it now rapidly sucks or more or less completely devours. [Upon disturbance the larva always emits from the mouth a considerable amount of milky fluid.] The color is more yellowish than it was before, and the power to stretch and travel on the venter on an even surface is still retained. In another week it forsakes the remnants of the pabular mass, and, by burrowing a short distance in the clear soil, avoids the deleterious decaying influences of these egg remnants. [An examination of such egg-masses as have been gutted and deserted by these larvæ shows no trace of excrement, and indicates that the fæces are trifling in quantity, and of a fluid nature. Fragments of the egg-shells are pushed up to the top of the mass as fast as the larva devours their contents, and, together with an occasional cast-off head, form the only rejectamenta.] In the soil it forms a smooth cavity, within which it lies stretched on one side, motionless and gradually contracting. The skin separates and becomes loose at the end of the third or fourth day, when it splits on the top of the head and thoracic joints and is worked toward the extremity, but never fully shed. The mouth-parts and legs are now quite rudimentary and tuberculous, the soft skin rapidly becomes rigid and of a deeper yellow color, and we have what has been called the semi-pupa (Pl. IV, Fig. 8). The term pseudo-pupa given it by Fabre is more appropriate, and I should prefer myself to call it the *Coarctate Larva*, for it is nothing but a rigid and dormant larval stage, having its counterpart in the well-known "flaxseed" stage of the Hessian-fly larva and in the so-called coarctate pupa of the Diptera generally. A similar dormant but less rigid larval stage occurs with many Tenthredinidæ in Hymenoptera, and in fact, the summer dormancy of certain Lepidopterous larvæ and the winter dormancy of others is analogous. We find something similar, therefore, in all the Orders undergoing complete transformations, but in no insects is the change so marked and exceptional or the freeing of the subsequent larva from the coarctate larva so striking as in these Meloïdæ. The insect has the power of remaining in this coarctate larval condition for a long period, and generally thus hibernates.

In spring the coarctate larval skin is, in its turn, rent on the top of the head and thorax, and there crawls out of it the *Third Larva*,[65] which differs in no respect from the ultimate stage of the second larva already mentioned, except in the somewhat reduced size and greater whiteness. The coarctate skin, when deserted, retains its original form almost intact. The third larva is rather active, and burrows about in the ground; but while there seems to be no reason why it should not feed, nourishment is not at all essential, and all my specimens have, in the course of a few days, transformed to the true pupa without feeding. In the transformation to pupa (Pl. IV, Fig. 9) the third larval skin is worked into a wrinkled mass behind, as is also the skin of the true pupa when shed. The pupa state lasts but five or six days, and before the wings of the imago are fully expanded, or the abdomen contracted, the general aspect of *Epicauta* forcibly recalls the mature *Henous*.

[64] None of the observers of *Meloë* or *Sitaris* mention the two molts which the second larva undergoes, though these doubtless occur in those genera as they do in *Epicauta*. Only by the most careful watching from day to day of a number of specimens have I been able to observe these molts; for the exuviæ are generally devoured as soon as they are cast, and this fact doubtless accounts for their not having been observed in the two genera first mentioned.

[65] The coarctate larva is, properly speaking, the third, and that following it the fourth; but just as I have preferred to designate as special stages of the second larva the stages between the first and fourth molts, so I prefer to call the last larva the third, to conform to the nomenclature now generally employed.

Like all parasitic[66] insects that nourish on a limited amount of food and possess no power to secure more, the blister-beetles vary greatly in individual size in the same species, and the larvæ have the power of accommodating their life to circumstances, and of assuming the coarctate larval form earlier or later according to the size of the egg-mass which they infest. I have had some interesting illustrations of this in my experiments with them. In an average sized egg-pod of the Differential Locust, however, there are more than enough eggs to nourish the largest specimen of *E. vittata*, and a few are usually left untouched.

The period of growth, from the first feeding to the coarctate larva, averages, as will be gathered from the foregoing, about a month; yet in the month of September, outdoors, under screens where I have had the Differential Locust oviposit for the experiment, I have known the full larval growth of *vittata* to occupy but 24 days. As this species occurs in the beetle state as early as June in the latitude of Saint Louis and as late as October, there are possibly two annual generations here and farther south.

LARVAL HABITS OF MACROBASIS AND HENOUS.

The characteristics of the triungulins of the blister-beetles, represented by *Epicauta* and *Henous*, are remarkably similar, and point to unity of habit.[67] The same holds true of the characters of the second, coarctate, and third larva, and of the pupa of *Epicauta* and *Macrobasis*. They are precisely alike; so that, while appreciable differences may be found in the triungulins, it is doubtful whether the subsequent developmental stages will indicate specific or even generic differences in species of similar size in these three genera.

That the eggs of *Epicauta* may exceptionally hibernate is possible, but, from their delicate nature, improbable. That the triungulins frequently do so there can be no doubt, especially in species like the Black Blister-beetle, which is found on the flowers of Solidago, Eupatorium, &c., till the end of October, and continues laying till frost. I have, at the present time (November 5), many of these last that are quietly huddled together, and, with winter temperature, will doubtless remain so; while others have worked in between the locust-eggs, there evidently to remain without feeding till spring opens. I have also found as many as five triungulins of this species curled up in the deep red mucous matter that surrounds the eggs of *Œdipoda phænicoptera*, all numb and torpid, and evidently hibernating.

RÉSUMÉ.

From the foregoing history of our commoner blister-beetles, it is clear that while they pass through the curious hypermetamorphoses so characteristic of the family, and have many other features in common, yet *Epicauta* and *Macrobasis* differ in many important respects from *Meloë* and *Sitaris*, the only genera hitherto fully known biologically. To resume what is known of the larval habits of the family, we have:

1st. The small, smooth, unarmed, tapering triungulin of the prolific *Sitaris*, with the thoracic joints subequal, with strong articulating tarsal claws on the stout-thighed but spineless legs, and, in addition, a caudal spinning apparatus. The mandibles scarcely extend beyond the labrum; the creature seeks the light, and is admirably adapted to adhering to bees but not to burrowing in the ground. The second larva is mellivorous, and the transformations from the coarctate larval stage all take place within the unrent larval skin. We have—

2d. The more spinous and larger triungulin of the still more prolific *Meloë*, with long caudal setæ, but otherwise closely resembling that of *Sitaris* in the femoral, tarsal, and trophial characters, in the subequal thoracic joints, in the unarmed tibiæ, and in the instinctive love of light and fondness for fastening to bees. The second larva is also mellivorous, but the later transformations take place in the rent and partly shed skins of the second and coarctate larvæ. We have—

[66] An insect is not properly parasitic that simply feeds on eggs, but the term is permissible and even necessary to characterize and distinguish those species which develop within and are confined to a locust egg pod from the predaceous species that are not confined but pass from one pod to another.

[67] The slight differences between some of the species are pointed out in the original descriptions.

3d. The larger and much more spinous triungulins of the less prolific *Epicauta, Macrobasis,* and *Henous;* with unequal thoracic joints, powerful mandibles and maxillæ, shortened labrum, slender femora, well-armed tibiæ, slender, spine-like, less perfect tarsal claws, combined with an instinctive love of darkness and tendency to burrow and hide in the ground. The second larva takes the same food as the first; its skin is almost entirely cast from the coarctate larva, while the subsequent changes are independent and entirely free of the shell of this last.

WHAT IS KNOWN OF THE LARVAL HABITS OF OTHER MELOÏD GENERA.

Mylabris, Fabr. (*nec.* Geoff.), according to V.-Mayet, is much less prolific than any Meloïds so far observed. The egg is 2·5 mm. long and ½ as wide, with a tolerably thick shell, and the embryo more fully bent within it. The triungulin has many of the characters of *Epicauta,* judging from the published description (*Ann. Soc. Ent. de Fr.,* 1876, p. cxcvi), which is, however, not sufficiently detailed as to the trophi. I doubt not that the genus will be found to infest locust-eggs.

Horia, Fabr., from what little is known of it, would seem to have a similar partial parasitism to *Meloë,* but on Carpenter bees.

Tetraonyx, Latr., was found by Guérin-Meneville in places frequented by bumble-bees.

The eggs of *Apalus,* Fabr., as well as its triungulin, are said to resemble those of *Meloë.*

Zonitis, Fabr., is known to develop in the cells of *Osmia* and *Anthidium,* and to have a coarctate larva much like that of *Sitaris.*

Soldier-beetle larvæ.—The larva of the Two-lined Soldier-beetle (*Telephorus bilineatus,* Say, Fig. 33, *a*) was found by Mr. J. I. Salter, of Saint Cloud, Minn., devouring the eggs, though by no means so common as the blister-beetle larvæ. This larva was first described, in 1871, by Mr. Packard; and its carnivorous habit first made known the same year by Mr. Riley, who found that it preyed upon the common apple-worm. The beetle has brown-black wing-covers, and a reddish-yellow head and thorax; the latter having two short, black longitudinal marks. It is found early in spring on various fruit-trees, upon which it doubtless feeds, as Mr. Packard records its feeding on the newly expanded leaves of the birch. The larva is of a rich velvety-brown color and will doubtless prey on many soft-bodied insects. Mr. N. Coleman, of Bloomfield, Ct., sent us specimens, in the spring of 1876, taken, under peculiar circumstances, in a well, where they must have been feeding upon small animals in the crevices between the bricks, from

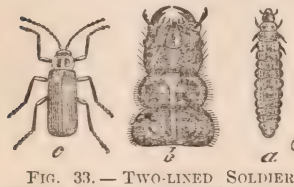

FIG. 33.— TWO-LINED SOLDIER-BEETLE.—*a*, larva; *b*, head and two first joints of same, enlarged; *c*, beetle. (After Riley.)

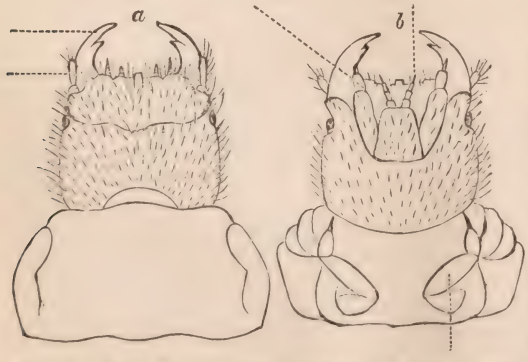

FIG. 34.—Head of larva of Two-lined Soldier-Beetle, greatly enlarged; *a*, upper; *b*, under side. (After Packard.)

which they occasionally fell into the water and instinctively adhered to the bucket. We quote his account:

In the latter part of November, 1875, I found an occasional larva on the bucket of water as I drew it from the well. At first I thought they were caterpillars; but the more I studied the less I could make any decision. One or two at a time were drawn up occasionally till Christmas—that day I drew up forty or fifty at once. I supposed I had secured all, but where they kept themselves I could not imagine; for a few days before I lost the bucket, and had to fish for it a long time. January 17 I drew up several larvæ, and a few days after two or three more came up. On January 25, 28, and 31, one or two were drawn up each day. February 2 I drew up two quite small ones; and on the 13th a few more of the large ones came up. March 6, some more of the full grown; March 7, some about half grown; March 31, some more larvæ; April 1, some more still; April 5, do. The well was frozen over quite hard several times during the winter; in March the water came up to within three feet of the top. Now, what are they? How have they lived, and where, during the winter?

I tried several times to keep some of them in a vessel of water, but they all died within a few days each time. Please let me hear from you as soon as convenient, as I am quite curious to know what they are.

TELEPHORUS BILINEATUS, Say.—*Larva* (Fig. 33, *a*).—*Body* 12-jointed, joint 1 longest, 4 shortest, the rest of about equal length; flattened; tapering slightly at each end; velvety; of a rich deep brown above, pale below; intersections deep and broadening from sides to middle of dorsum; two deep longitudinal lateral furrows, and two, less deep, ventral ones; medio-dorsal pale line continuous on the thoracic joints but showing only on the sutures of the rest; joints 2 and 3 each with a large sunken suboval brown spot each side of dorsum; these spots with a pale center; in a line with these on all the abdominal joints but last, is a more or less distinct, slightly sunken, pale line, and still another parallel with it further out on the side. Between these pale lines, on every joint but the last, is a slightly elevated, dark, bead-like tubercle which might readily be taken for spiracles; but these last, which are dark and quite small, are placed on the anterior edge of the first eight abdominal joints, in the upper lateral furrow, and between the first two thoracic joints—there being nine pair in all; anal joint with a moderate proleg. *Legs* rather short, pilose, the tarsus terminating in a prominent and sharp claw. A pale anal pseudopod. *Head* flattened, divided superiorly a little beyond the middle by a transverse suture, the basal portion of an opaque, velvety, sooty-black; the anterior portion polished, forming three well-defined lobes, with the anterior edge irregularly broken; eyes prominent, placed laterally immediately before the occipital suture; antennæ inserted in a deep socket, 2-jointed, the second four times as long as first, and bearing a small subjoint at tip; labrum not visible [Packard describes it as "broad and perfectly square in front, with a median notch dividing the edge into two slight lobes." As Walsh describes that of *Chauliognathus* as being retractile, it is probably retracted in my specimens, which are alcoholic]; mandibles falcate, with a strong tooth a little beyond the middle of the inner edge; beneath, the anterior edge is deeply and semi-circularly cut out; mentum extending between maxillæ for two-thirds their length; maxillæ large, projecting beyond labium, especially on the inside, where they seem to be produced into a slight point; maxillary palpi 3-jointed, the second twice as long as the first, the third rudimentary; labium small, formed of a basal quadrate piece and two palpigerous pieces that are soldered together; labial palpi 2-jointed, the second rudimentary.—[*Fourth Mo. Ent. Rep.*

FIG. 35.—ERAX BASTARDII.—*a*, fly, *b*, pupa; *c*, larva. (After Riley.)

Asilid larvæ.—We have on several occasions found a large Dipterous larva (Fig. 35, *c*) preying upon the eggs of our locust, which larva we recognized as that of *Erax Bastardii* which we had reared in previous years. A specimen of the same species received from Minnesota, where it was also found preying upon locust-eggs, was kept for some time by Miss Emma A. Smith, of Peoria. We have, also, a larger larva of the same family, and, doubtless, that of some true *Asilus*, which was found

at the same work. The Asilid-flies have been justly styled the hawks of the insect world. They pounce upon many kinds of insects, and as we shall presently see, are very fond of locusts. Their larval habits are but imperfectly known, but so far as known they are said by most authors to be vegetarian, Harris having reared the Silky Asilus (*Asilus sericeus*, Say) from larvæ feeding on the roots of rhubarb. The egg-feeding habit here recorded would show that the carnivorous habit of the mature flies belongs likewise, in some species at least, to their larvæ.

ERAX BASTARDI.—*Larva.*—(See Fig. 35, *c*.) Length 1.05 inches. Only twelve joints, the three anterior and the three posterior ones tapering gradually, the rest of equal width; slightly depressed; translucent yellowish-white; the chitinous covering tolerably firm, however; a swollen lateral ridge; two rufous dorsal spiracles on joint 1, and two similar ones on joint 11. Head dark brown, very retractile, pointed, divided at tip into two mandibulate points, and having two unguiform appendages; anal segment with two depressed longitudinal lines above, ridged on anterior edge, and with a central depressed line below. It makes use of its head in crawling.

Pupa (Fig. 35, *b*).—Stout, honey-yellow; the leg and wing-sheaths soldered together though separated from the abdomen; eyes large and dark; head with two large brown spines in front, and a lateral set of three rather smaller ones; thorax with two small thin rounded dorsal projections, and a set of two small lateral spines just behind the head; abdomen, with each segment ridg d in the middle and furnished on this ridge with a ring of brown blunt thorns sloping backward; anal segment with a few rather stouter spines.—[*Second Mo. Ent. Rep.*

Click-beetle Larvæ.—We have discovered three distinct larvæ of this family preying upon the locust eggs. One of these (Fig. 36, *a*) is by far the most common, and was found with the same habit on several occasions by Mr. A. N. Godfrey, of Manhattan, Kans. These larvæ are popularly known as wire-worms, and there are many different species, some of which are well known to be grievous pests to the farmer, by destroying the roots of various cultivated plants. We have, however, long known that some species were carnivorous,[68] and the egg-feeding habit of the three in question is confirmatory evidence. We have failed to rear any of them to the perfect state, and they do not accord with any described species that have been determined.[69] Fig. 36, *a*, shows the more common species, with (*b*, *c*) its head and anal joint; *d*, *e*, the anal joints of the other two.

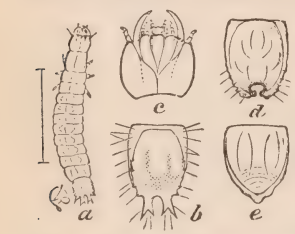

FIG. 36.—*a*, Elaterid larva that feeds on locust-eggs; *b*, head from beneath; *c*, anal joint from above; *d*, *e*, anal joints of other species with the same habit. (After Riley.)

Ichneumonid (?) Larva.—"Next to the Anthomyia egg-parasite in importance is a much larger, more sluggish, yellowish grub (Fig. 37, *a*), measuring about half an inch when extended, which is found within or beneath the locust eggs, lying in a curved position, the body being bent so that the head and tail nearly touch each other. It is a smooth grub,

[68] Mr. Riley has reared *Hemirhipus fascicularis* (Fabr.) from larvæ preying on those of *Cyllene pictus* (Drury); *Elater luctuosus* Lec. from larvæ that fed on those of *Dendroides canadensis* Latr., and *Cucujus clavipes*, Fabr. He has also bred *Melanotus communis* Gyll. from a Black oak badly infested with *Chrysobothris femorata*.

[69] The larva of *Elater luctuosus* is dark brown, with the anal joint punctate, diminishing to a point, and terminating in a sharp thorn. That which Fitch considers *Melanotus communis* has three blunt dentations and four longitudinal impressions on the anal joint, somewhat as in Fig. 36, *c*. That which he believes to be *Agriotes truncatus* Melsh. (the *A. obesus* of Harris, and described in full by Dr. G. H. Horn in *Can. Ent.* vol. iv, Fig. 4, as *A. mancus* Say), has a smooth, rather pointed anal joint, with two conspicuous dorsal spots. That of *Hemirhipus fascicularis* is broad, with a narrow, upturned anal joint, having a few rounded thorns and two terminal sharper and larger ones. That of *Ludius attenuatus* has a perfectly smooth and polished anal joint.

with a very small, brown, flattened head, with the joints near the head swollen, and the hind end tapering, and with deep, translucent sutures beneath the joints, which sutures show certain venous marks and mottlings, especially along the middle of the back. It exhausts the eggs, and leaves nothing but the shrunken and discolored shells."

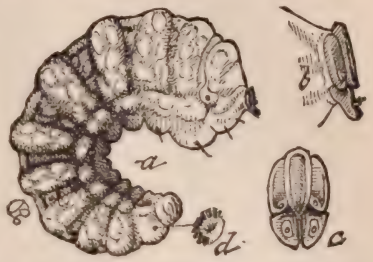

FIG. 37. — UNDETERMINED EGG-PARASITE OF ROCKY MOUNTAIN LOCUST.

This parasite has been found in Minnesota, Iowa, Kansas, and Missouri, and in 1876 destroyed about one per cent. of the eggs. The following letters refer to it:

The other day, as I was strolling through the fields, I stopped to examine some eggs. I found the ground in spots quite full of white grubs, worms or maggots, whatever they may be called. Many of them were in the egg-pods, busy at work. I collected a few, and sent to you in a small vial by mail for your examination. The ground was high and dry where found.—[S. D. Payne, Kasota, Le Sueur County, Minn., September 28, 1876.

I think the Silky Mite has done good service in destroying eggs in one or two counties, particularly Nobles. But we are getting, in addition, continual newspaper reports of white grubs destroying the eggs. I started out to see for myself, and have found a number, which I send you.—[A. Whitman, Saint Paul, Minn., September 7, 1876.

Though we have endeavored to rear quite a number of them to the perfect state, we have met with no success. The characters of the grub show it to be Hymenopterous, and probably of the family Ichneumonidæ. It hibernates in various stages of growth, and we have found the larva unchanged throughout spring and early summer, and have kept a few alive from the fall of 1876 to September, 1877, all dying in the end unchanged and without spinning a cocoon. The larva of *Pimpla instigator* is said by Motchulsky to prey on the eggs of European locusts.

ICHNEUMONID (?) LARVA.—Average length, 0.50 inch. Body curved, glabrous, tapering posteriorly, swollen anteriorly. Color opaque whitish, with translucent yellowish mottlings, and some venous marks at sutures, especially along medio-dorsum. Sutures deep. A lateral row of swellings. Head small, flattened, dark brown, in five pieces, consisting above of a frontal ovoid piece and two lateral pieces of somewhat similar form, and each bearing near tip a minute, two-jointed palpus; beneath of two broad, subtriangular jaws, having forward and lateral motion, and each, also, bearing near the center, in a depression, a two-jointed feeler. A spiracle each side in a fold between joints 2 and 3, and another on each side of the penultimate joint, 12. None otherwise perceptible.

Miscellaneous Species.—In addition to the foregoing insects that attack the eggs, different species of ants have been reported to do so to some extent. We have also found certain Myriapods, and especially a species of *Mecistocephalus* within the egg-mass, and have witnessed the common White Grub (larva of *Lachnosterna fusca*) actually feeding upon the eggs, thus giving another conclusive proof that an essential vegetable feeder will exceptionally take to soft animal food.

Mr. S. H. Scudder (Proc. Bost. Soc. Nat. Hist., vol. xii, p. 99) has recorded the rearing of a Chalcid-fly (Fig. 38) from the eggs of the Carolina locust; and we have received from R. B. Potts, Worthington, Minn., an

egg-mass of our Rocky Mountain locust, every egg of which contained a Chalcid pupa. These pupæ were too dry to permit of rearing the imago, but they were probably of the same species as that reared by Mr. Scudder. It is a black, deeply pitted fly (Fig. 38, *a*), about 5mm long, belonging to the subfamily *Eurytomides*. It does not fully correspond with any of the genera defined by Westwood, Walker, or Snellen Van Vollenhoven. We hesitate to found a new genus on a single sex, but in order to christen the insect, we subjoin a brief definition:

FIG. 38.—CALOPTENOBIA OVIVORA.—*a*, female; *b*, her antenna. (After Riley.)

CALOPTENOBIA, nov. gen.—♀, body elongate; strongly rugoso-punctate. Head as broad as thorax; ocelli barely distinguishable, widely apart; antennæ 12-jointed (scape + 11), the scape nearly as long as the flagellum, which is curved, slightly clavate, with joints 3, 4, 5, shortest, the others subequal, the terminal one faintly divided. Thorax elongate; collare narrow; præscutum large and swollen; scutellum small and rounded behind; metanotum concave behind, with the sides dilated and forming almost a quadrangle. Pedicil short and stout. Abdomen flattened, fusiform, 6-jointed; joint 2 excavated anteriorly, joint 3 as long as 1 and 2 together, the terminal joint very small and indistinctly separated. Wings not reaching to tip of abdomen when closed; hind pair with a fringe of sparse cilia on inner border. ♂ unknown.

C. ovivora, n. sp.—♀, color pitchy black, with sparse gray pubescence. Legs, scape, and basal joint of flagellum honey-yellow. Wings hyaline. Head and thorax broadly and confluently rugoso-punctate. Abdomen longitudinally striate. Length 5mm.

Four specimens from eggs of *Œdipoda Carolina*.

Finally, the Locust Mite, which we shall now consider, is, in the mature state, one of the most effective destroyers of the locust eggs.

ANIMALS THAT PREY UPON THE LOCUST AFTER IT IS BORN.

Red mites.—There are at least two species of red mites, and probably more, that attack the Rocky Mountain locust, the most common of which is—

THE LOCUST MITE (*Trombidium locustarum* Riley).—One of the most interesting as well as one of the most important of our locust enemies is what we may popularly call the "Locust mite." It forms a true link between those articulates which prey on the eggs and those which prey on the locusts, since it combines both traits. Referred to in previous writings under the name of the Silky mite, its natural history was first fully made out by Mr. Riley during the past summer. It differs so much in infancy and maturity that it has been referred to distinct genera, and was always known under two different names. During either period it proves a bitter enemy to the locust. In the mature form it lives in the ground, feeding upon all sorts of soft animal and decomposing vegetable matter. When the locust fills the ground with its eggs this mite flourishes upon the abundance of food which these afford, sometimes teeming to such an extent as to give the ground a scarlet hue. How numerous and how beneficial to man this mite may be as a destroyer both of the locust and its eggs is well illustrated by the statements of correspondents in the appendices (App. 18) where it is so fre-

quently referred to as the "red mite," the "little red bug," &c., as well as by the following extracts:

The course of the locusts was brought to a sudden halt by the operation of some parasite, appearing in the shape of small red mites, which attach themselves to the body, under the wings, where they suck the carcass to a dry shell; the dead bodies of the grasshoppers almost covering some plants, where they have taken hold of a leaf or stalk, and clasped it, with a dead embrace; many others fall to the ground to die, too weak to rise again. In a half day's examination, where they were very thick, we failed to find more than two grasshoppers not so attacked, and this was not local: for a distance of thirty miles across the country they were found similarly affected.—[Editorial correspondence of the *Prairie Farmer*, August 21, 1869.

A discovery has been made of great interest. A small red bug or spider, about the size of a small kernel of wheat, is found in great numbers, creeping into the holes to the grasshopper eggs and eating the contents of the eggs voraciously. Great numbers were found in the act of eating the eggs, with empty egg-shells in the same nest. The extent of the little friends is not limited, but they have been seen in many localities in different directions in this place. Mr. J. D. Johnston, Antrim, proved conclusively that these red bugs are making sure work among the eggs.—[*Madelia* (Minn.) *Times*, 1874.

Last evening, when we reached Worthington from Lake Shetek, there was quite an excitement in Worthington, owing to the fact that the citizens were generally convinced that a red parasite was destroying the grasshopper eggs. I examined the matter carefully myself, and became convinced that the destruction of the eggs in that immediate vicinity was well assured; but I determined not to write you and excite any hope until a further and more complete examination could be had. We therefore furnished our Bohemian friends with a bottle of the eggs and their pests, and the commission left in high spirits. We postponed further investigation until this morning, when I left and prosecuted the examination with vigor. The farmers in the vicinity knew nothing of these signs of deliverance until the visitors from Worthington reached them, and I feel safe in saying to you that in a circle of ten miles from Worthington there will scarcely be an egg left by to-morrow night. I send you a bottle herewith containing the cones and the parasites. We could scarcely find a cone or sack, except as they were indicated by the parasite on the surface; and each cone, which was not entirely destroyed, had from five to fifty of the red laborers at work upon the eggs. We found scores of cells with no eggs left, except the shells. * * * I stopped for fifteen minutes one and a half miles west of Wilder, where Section-Foreman Smith took me to that portion of his farm where eggs were deposited. We could find none by general digging, but wherever we found, as we frequently did, the red parasite on the surface, we found the cone beneath, with the parasite at work consuming the eggs. * * * I am aware that two years ago this parasite was found working upon the eggs at Madelia and other places, but here we have the remedy almost as soon as the eggs are laid, while in the former instances the parasite was only discovered in the spring.—[Letter from Ex-Governor Stephen Miller, written from Windom, Minn., August 15, 1876.

We send herewith a box of grasshopper eggs, together with the "silky mite," of which so much has been said. You can see a sample of the work they are doing. They are over the ground and in it wherever eggs have been laid. They suck the eggs, leaving the bare shell. We have talked with farmers from all parts of the county, and they all tell the same story—not a cell to be found that is not partially or wholly destroyed. We have personally inspected them in more than twenty different places, and are satisfied that in this county the eggs of the festive g. h. are a "total wreck." Allow us to suggest that you call for a report from every county in the State that has been infested by them.—[Letter to *Pioneer Press and Tribune*, from Bell & Gruelle, Worthington, Nobles County, Minnesota, August 16, 1876.

I send, inclosed in a circular tin box, mailed with this, some dirt containing grass-

hoppers' eggs, and also the *red mite* or *spider* that sucks them, as you will perceive on examination. I trust they will be received in good order. I send them at the request of A. Whitman, of Saint Paul, of this State, with whom I am corresponding sometimes on this grasshopper matter.—[Letter from R. B. Potts, U. S. N., Worthington, Minn., August 18, 1876.

We have received a copy of the Yankton *Press* and *Dakotaian*, of April 25, containing an article calling attention to the fact that a parasitic insect is devouring the eggs of the locusts all over Southern Dakota. The insect is described as a "little red bug," and also as the same parasite which is found on the bodies of fully-grown and migrating locusts. This is evidently a mistake, the two being entirely different insects in habits and appearance. The "little red bug" is known as the "silky mite," and is described in Riley's Seventh Report under the name of *Trombidium sericeum*. Its habit of eating the eggs of the locust was reported as early as 1874. It is also described in Riley's Ninth Report, which has just been issued. In the locality mentioned it is so numerous that scarcely a sac of eggs has escaped, and farmers are very much encouraged concerning their crops.—[*Country Gentleman*, May 10, 1877.

During the fall of 1876 reports were received from various quarters, especially the southwestern counties, denoting the presence of the Silky mite in great numbers, while various larvæ were discovered at work upon the eggs almost everywhere. The Silky mite was found to be still more numerous in the spring, sometimes so thick as to redden the ground, and in localities where it had not been seen in the autumn. Of replies to the inquiry of the Entomological Commission, "proportion of eggs that failed to hatch, and probable cause of failure," nine out of thirteen (in Minnesota) express the opinion that a large percentage (one-half or more) failed to hatch, and the cause generally assigned is the Silky mite. Testimony on this point can apply with exactness to only such little cases as come under each man's particular notice, but the replies, taken with similar reports, denote that considerable quantities of the eggs were destroyed before hatching.—[Allen Whitman, Saint Paul, August, 1877.

In conversing with a gentleman this evening, he says: "What grasshoppers remaining here are now being destroyed by a bug, a small, 'red bug,' which are now upon their wings sapping the life out of them. They are about the size of a chintz bug."—[E. D. Barton, Sarcoxie, Mo., July 12, 1877.

The warm spell has hatched out a great number of the little silky mites. In fact, many farmers tell here that the ground is red with them in places.—[A. Whitman, Saint Paul, Minn., April 17, 1877.

A reliable man from the next county to this (Emmett) informed me that his garden soil was red with the little insect often spoken of, and that they were going for the eggs with a vengeance.—[John Walker, Emmettsburg, Iowa, April 17, 1877.

I have found many red parasites on the locusts, larger ones on those in the pupa state than on those that had more fully developed wings. Have found no internal parasites.—[G. M. Houston, Harrisonville, Mo., June 8, 1875.

The red parasite seems to feed more upon the indurated mucous sac inclosing the eggs than upon the eggs themselves; yet, I think, where the covering is destroyed, the eggs, in most instances, do not hatch. The red parasite is the first to attack the young, by depositing its eggs [young mistaken for eggs] upon them. I have seen so many of these upon young locusts that they sucked all the vitality out of them.—[J. G. McGrue, Audubon, Minn., June 20, 1877.

There is some insect that appears to deposit small red eggs, from one to a dozen or more, under the wings of the grasshoppers. I have seen them in large masses, and have found them on those with their wings just starting. I find, also, that at least nine-tenths of the full-fledged ones have them, and that they are dying all the time in great numbers in consequence.—[G. Z. Craig, Diamond City, Jasper County, Missouri.

In spring, the female lays between 300 and 400 minute spherical, orange-red eggs in the ground (Fig. 39, *a*). They are usually from one

to two inches beneath the surface and in a slightly agglutinated mass, which, however, easily becomes scattered upon disturbance of the soil. From these eggs, in due time, there hatch little orange mites (Fig. 39, *b*), which differ from the parent in having but six legs. The six-legged form belongs to Latreille's genus *Astoma*, erected when naturalists had no suspicion that it was purely a larval form. The specific name *locustarum* was first proposed for it by B. D. Walsh,[70] but Dr. Le Baron afterward gave it the name of *Atoma gryllaria*,[71] in connection with a detailed description.

Active when they first hatch and impelled by instinct, these little six-

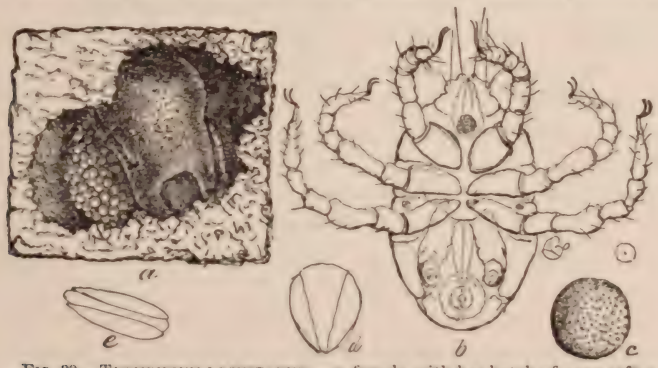

FIG. 39.—TROMBIDIUM LOCUSTARUM.—*a*, female with her batch of eggs (after Emerton); *b*, newly hatched larva—natural size indicated by the dot within the circle; *c*, egg; *d*, *e*, vacated egg-shells (after Riley).

legged specks crawl upon the locusts and fasten to them, mostly at the base of the wings or along their principal veins, just as a tick fastens to a dog or a sheep, or to man. Thus attached to their victim, they suck

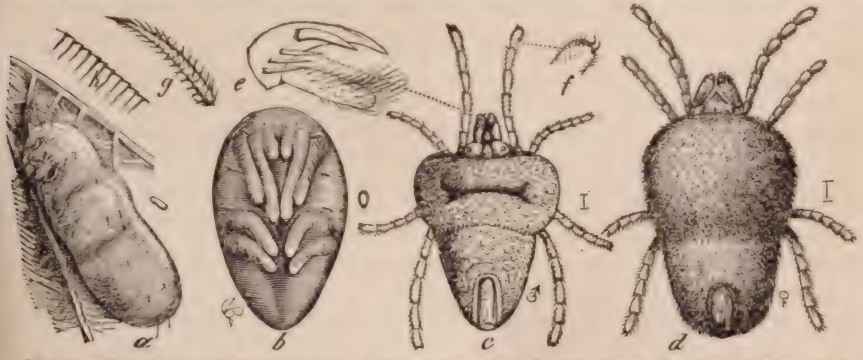

FIG. 40.—TROMBIDIUM LOCUSTARUM.—*a*, mature larva when about to leave the wing of a locust; *b*, pupa; *c*, male adult when just from the pupa; *d*, female—the natural sizes indicated to the right; *e*, palpal claw and thumb; *f*, pedal claws; *g*, one of the barbed hairs; *h*, the striations on the larval skin (After Riley.)

its juices and swell until the legs become invisible. It is in this condition (Fig. 40, *a*) that they are most often noticed, presenting to the ordi-

[70] Practical Entomologist, i, p. 126.

[71] Le Baron's Second Illinois Ent. Report, 1872, p. 156. The author employs the term *Atoma*, which, though at first employed by Latreille, is corrected to *Astoma* in his Genera Crustaceorum et Insectorum, i, p. 162 (1806).

nary observer the appearance of a bright red oblong-ovoid body growing from the wing. They are so firmly attached by the mouth, so immovable, and with the legs so short and hidden, that persons unfamiliar with their true nature might easily mistake them for some natural growth or excrescence. That they are often so numerous as to weaken and kill their victim, reports, as well as our own experience, clearly prove. Professor Aughey, of Nebraska, has observed that these red mites increase on the locusts immediately after a rain, and it is not improbable that they hatch more freely or move more freely in wet weather, though the true explanation of the facts observed may also be found in the repose of the locusts during such weather, and the greater ease with which the mites consequently crawl upon them. They are most numerous on the winged locusts, though also found upon the young, unfledged insects, especially the pupæ.

In due time, these swollen bodies let go their hold and drop to the ground, where, clumsily and with difficulty, they crawl under the first shelter afforded by some bit of loose earth, or a stone. Here they remain quiet for two or three weeks, gradually swelling and changing form. During this change, the pupa state is assumed, but not by shedding any skin, as do true insects in going through their transformations. New legs, feelers, and mouth-parts form under the old skin, which, with its now useless legs, distends so as barely to cover the new parts, which are all appressed to the body very much as in the pupa of a beetle (Fig. 40, *b*). Finally both the distended larval skin and the new one that incases the pupa burst, and release a creature quiet different from the former *Astoma*—in fact, none other than the 8-legged *Trombidium* (Fig. 40, *c*). We thus see that from the time this mite hatches, through all its growth and changes, but one molt takes place. The mature form passes the winter in the ground, and is active whenever the temperature is a few degrees above freezing-point.

Only two species of the genus *Trombidium* have been described in America, viz: *scabrum* Say, and *sericeum* Say.[72] The descriptions in both cases are brief, and lacking in structural details and in measurements. The locust mite under consideration has been hitherto referred to *sericeum*, but the characteristic polished anal plate precludes the reference, and we define it under the name of *locustarum*. Since the time when it was established by Fabricius, evidently on the characters of the European *T. holosericeum*, the genus *Trombidium* has been greatly modified by different authors. The species have been variously arranged according to relative length of legs, position of eyes, divisions of the body, &c. As restricted at present, the genus is thus characterized: Abdomen swollen, especially in front, where it is broadest; cephalo-thorax small and narrow, with two eyes, superior and barely raised; legs 7-jointed, palpate, with two minute terminal hooks, the front pair longest, the two front pairs widely separated from the two hind pairs; mandibles un-

[72] Journ. Ac. Nat. Sc. Phil ii, 1821, p. 70.

guiculate; palpi large, free, the penultimate joint strongly ungulate, and the terminal joint forming a movable thumb upon it. Larva 6-legged, parasitic; defined under the generic names *Astoma*, *Leptus*, *Lepostomus*, and *Ocypete*. Many species have been described in Europe, but the one in question differs from all of them as given by Gervais.[73]

Trombidium locustarum Riley.—Egg 0.12mm in diameter, spherical, full of granulations, pale orange-red in color, becoming more pointed at one end before hatching (Fig. 39, *d*), the shell splitting across and the severed sides rolling toward each other when vacated (Fig. 39, *e*).

Larva.—When newly hatched, pale orange-red, 0.14mm long, ovoid, the body with but three transverse sutures, one anteriorly, one between first and second, and another between second and third pair of legs; dorsum with several transverse rows of about six piliferous points; head somewhat narrowed, showing four minute swellings, each giving rise to a rather long hair; mouth-parts small and indistinct, with a dusky, granular spot at their base; legs 6-jointed, inclusive of fixed coxal piece, the third joint longest, hind pair somewhat longer than the others, all tipped with two well-developed claws, those on front pair the longest; what appears to be a rudimentary subcutaneous fourth pair; no anal setæ.

Full-grown larva.—1.6mm long, with the whole body greatly distended and elongated, the elongation being principally from the posterior dorsal portion, so as to bring to view four hairs at the end; body showing two principal transverse constrictions, one about the middle, the other above it, while the whole surface is finely and transversely striate

Pupa.—1.7mm long, one-half as broad. Either pale yellow or orange-red, polished, swollen and rounded anteriorly, more tapering posteriorly, the dorsum well arched; two transverse impressions, at first noticeable but subsequently obliterated; palpi and legs formed under the larval skin, their ends finally projecting from it and more or less free; traces of the shriveled larval legs widely separated.

Adult.—When first from pupa the color is orange-red, with a distinct transverse constriction about the middle, and a deep transverse impression in the broad fore part. The species is characterized by the palpal claw consisting of one large hook, with a second smaller one originating from its middle, and three stout spines from near its base, and by the thumb being of uniform diameter, armed with rather long hairs terminally, and reaching to or very little beyond its tip; also by a sunken polished plate at the end of the body dorsally; the plate but sparsely covered with hairs, elongate, square in front and broadening behind. The legs have the terminal hooks very short and blunt, the front pair is longest, the second shortest. Hairs of body barbed, slightly curved and attenuated. The scissor-like mandibles are faintly toothed within. With age the color intensifies to scarlet, but the legs, palpi, and ventral surface are always more pale and silvery than the superior part of the body. The male is smaller than the female, has more intense color, relatively somewhat longer legs, with the body more pointed behind and more deeply constricted; the anal plate more narrow; ventrally his body is more distinctly constricted toward tip, and more deeply impressed longitudinally; also with the genital impression more distinct. His body becomes more creased and impressed with age, while that of the female becomes broader and more smooth and swollen. Average length of female when full-grown about 3 millimeters; male about 2 millimeters.

We de-spread. We have it from Manitoba, Texas, various Eastern States, and from California.

In all the egg-masses we have examined, the number of eggs ranged between 300 and 400, the mass being irregularly globose, and the eggs but loosely adhering to each other. We have not been able to ascertain the exact length of time required for the full development of the larva after attachment, but it is brief, and seldom exceeds a fortnight, while the final transformation, after detachment, occupies but three or four days. Though the motion of the swollen and detached larva is slow, the legs move about with considerable rapidity; yet in the gradual change to pupa they shrink and are partially drawn in. Since De Geer's time it has been known that some of the octopod mites are hex-

[73] Suites à Buffon. Aptères. 1844.

apods in their early life, and there can be no doubt but that all the *Trombididæ* have hexapod larvæ. In addition to the locust mite above described, we have found another larval form attacking the mature *C. spretus*. It is at once distinguished from the larva of *locustarum* by the more prominent head, by the longer, more slender legs, which are 7-jointed, the joints increasing in length to the penultimate, which is longest, and by the hairs, whether on the body, legs, or palpi, being long, tapering, and barbed. It is possibly the larva of a large species, which we have called *Trombidium giganteum*, distinguished by the following characters:

FIG. 41. — TROMBIDIUM GIGANTEUM. — *a*, pedal claws; *b*, labial claw and thumb. (After Riley.)

TROMBIDIUM GIGANTEUM Riley.—Adult 8 mm. to 9 mm. long; pyriform, somewhat flattened; no pronounced constrictions, but various dorsal irregularities; usually about five pairs of circular depressions connected by transverse ones on anterior two-thirds, and a triangular series posteriorly. Barbed hairs long and tapering, but very dense and even. Color deep scarlet, the legs concolorous; eyes dark. Characterized by the penultimate palpal joint forming a single claw with a prominent notch, while the terminal thumb is large, extending one-third its length beyond the claw, clavate, and with the inner side of its broad end flattened; the claw, as well as the thumb, having sparse hairs; terminal joint of legs squarely docked, with the claws reaching but little beyond the side.

Living in the ground. Nine specimens examined.

We have also reared to the perfect state the well-known *Astoma* parasite that attacks the common house-fly (*Musca domestica*) in this country, and will add a description of it by way of comparison, as it may also be found to attack locusts.

FIG. 42.—Larva of TROMBIDIUM MUSCARUM. (After Riley.)

The larva (Fig. 42) has the same mode of transformation as *T. locustarum*, but is much more active after detachment, while the gradual shrinking and withdrawal of the larval legs during the transformation to pupa is much more easily observed. The species is distinguished from *T. locustarum* by the following characters:

TROMBIDIUM MUSCARUM Riley.—*Larva* distinguished from that of *T. locustarum* by the greater relative length of legs, and by the hairs on the body being much longer and more conspicuous; also by the more distinct transverse sutures, of which there are four. Transverse striations noticeable soon after attachment. Full-grown larva also more active.

FIG. 43. —TROMBIDIUM MUSCARUM.—*a*, labial claws and thumb; *b*, pedal claws; *c*, barbed tuberculous hair. (After Riley.)

Pupa.—More rounded behind.

Adult.—Average length 1.2 mm.; color bright and pale scarlet; legs very pale and with the terminal joint fusiform and the claws much longer than in *T. locustarum*, and more nearly as found in the larva; body rounded, very little narrower behind, with no impressions or other marks. Barbed hairs of body sparse, short, blunt, and tuberculous, giving a beautifully echinulate appearance under the microscope. Genital depression circular; penultimate palpal joint ending in two small, equal, blunt claws, the thumb being very small, tuberculous and not reaching its tip. No marked sexual differences.

Many specimens examined.

The mode of growth of these mites may be more clearly illustrated by a brief reference to a common red water-mite (*Hydrachna belostomæ* Riley) which we have studied. The mites of the typical genus *Hydrachna* are, in reality, the aquatic representatives of *Trombidium*, and have a precisely similar mode of development. We have not had the eggs, but in Europe they are known to be laid in spring in holes in soft-stemmed aquatic plants.

The young larva (Fig. 44, *b*,), like that of *Trombidium*, is pale red, hexapodous, and with the legs 6-jointed, including the coxal joint. It has the mouth-parts retracted, and is characterized by two dark eye-spots anteriorly, and by the swollen second joint of the palpi showing at each anterior corner. Moving about in the water, these young larvæ fasten, often in very large numbers, to different aquatic insects. Water-bugs of the family *Belostomidæ* are particularly subject to attack, and especially *Zaitha fluminea* (Say),[74] upon a single specimen of which we have sometimes counted over 500. They are able to fasten to the bug by means of several sharp hooks at the end of the palpi. Once fixed, the head and mouth-parts stretch until they become separated by a neck from the main body, the transparent skin of which rapidly swells and elongates so as to form a bag, with the more solid, dark red parts visible anteriorly (Fig. 44, *a*). The maxillæ penetrate and extend beneath the chitinous covering of the host, until they form a long, pointed thread. The legs curl up, become useless, and are more or less withdrawn, and the larva gradually passes to the pupa state within this bag, which becomes more and more swollen and rounded posteriorly, and finally bursts to release the adult mite. This bag-like larva was looked upon as an egg by many old authors, and was made the type of the genus *Achlysia* by Audouin. The adult swims actively about in the water, but before attaining maturity fixes to some plant, and undergoes another molt without material change of form.

FIG. 44.—HYDRACHNA BELOSTOMÆ.—*b*, newly hatched larva; *a*, larva soon after becoming fixed; *c*, mature larva with pupa forming within; *d*, adult; *e*, its pedal claws; *f*, palpal claws of larva. (After Riley.)

HYDRACHNA BELOSTOMÆ Riley.—*Larva.*—Hexopodous. Elliptic-ovoid. Pale red, with two dusky eye-spots. Legs 6-jointed, including coxæ; terminal joint longest; claws very small. Surface closely and evenly studded with minute points. Palpi drawn beneath the head, with the second joint greatly swollen, and showing like an eye at each anterior side of the body; the three terminal joints indistinctly separated, and each armed with a sharp hook. Becoming elongate and more or less pyriform, with a distinct neck when fixed.

Pupa formed within the bag-like body of larva.

Adult.—Average length when first from pupa 1.5 mm.; globular; color dark blood-brown; body smooth; legs with but few hairs, terminal joint truncate and with two very minute claws; palpal claws very small and the thumb no longer.

Ground-beetles.—We have seen that in the larva state several of these insects attack locust-eggs. The perfect beetles are among the

[74]=*Perthostoma aurantiaca* Leidy.

most active pursuers and devourers of the locust itself. The beetles of this family (*Carabidæ*) are essentially predaceous, and most of the larger species doubtless feed upon locusts when they get opportunity. The species which we have most often found at the work are the Fiery Calosoma (*Calosoma calidum*, Fig. 45, *b*) and the Elongate Ground-beetle (*Pasimachus elongatus*, Fig. 46). In ditches, where the young had collected, we have also found attacking them, *Calosoma externum* Say, *C. scrutator* (Fabr.), *C. wilcoxi* Lec., *Harpalus caliginosus* (Fabr.), *H. pennsylvanicus* (De Geer), and *Elaphrus ruscarius* Say. Mr. H. A. Brous also found *Pasimachus punctulatus* preying on them in western Kansas.

FIG. 45.—CALOSOMA CALIDUM.—*a*, larva; *b*, beetle. (After Riley.)

FIG. 46.—PASIMACHUS ELONGATUS. (After Riley.)

FIG. 47.—HARPALUS CALIGINOSUS.

Tiger-beetles.—These are swift-running and flying beetles (*Cicindelidæ*) with predaceous habits, their larvæ living within cylindrical holes, and entrapping any unwary insects that may chance to come within reach of their formidable jaws. These larvæ are characterized by the large and flattened head, and by having two tubercles on the back of the ninth joint, each tubercle ending in two recurved hooks, which support the creature in any part of its burrow. Various species[75] in the perfect state are known to attack the Rocky Mountain locust; and Mr. J. K. Moore, of Saint Peter, Minn., sent us last summer the *Cicindela repanda* (Fig. 48) with the remnants of various specimens which it had partly devoured. One would scarcely suppose, however, that the stationary larvæ of these beetles could succeed in entrapping such an active creature as our locust. Yet at Omaha, Nebr., last June, we found that of the young locusts which were collecting on the steep clay banks

FIG. 48.—CICINDELA REPANDA.

FIG. 49.—CICINDELA 6-GUTTATA.

FIG. 50.—CICINDELA SPLENDIDA.—*a*, larva; *b*, head of same enlarged; *c*, beetle (Emerton, *del.*)

FIG. 51.—CICINDELA VULGARIS.

[75] Mr. Brous found the following species preying on *spretus* in Western Kansas in 1876: *Cicindela pulchra* Say; *C. scutellaris* Say; *C. 6-guttata* Fabr.; *C. fulgida* Say; *C. vulgaris* Say; *C. circumpicta* Laf.; *C. formosa* Say; *C. 5-punctulata* Fabr.

that abound there quite a number fell victims to the larvæ of the Splendid Tiger-beetle (*Cicindela splendida* Hentz), the burrows of which are abundant in such situations. In the course of two hours' digging we found 19 young locusts that had been dragged to the bottom of the burrows of this species, and were then and there being devoured. We introduce a figure of this larva (Fig. 50) and of the beetle, which is a brilliant species, the wing-covers being of a burnished coppery color, with green reflections, and the rest of the body either metallic blue or green.

FIG. 52.—AMBLYCHILA CYLINDRIFORMIS.

One of the most interesting species of this family that preys upon the locust in Western Kansas is the elegant insect (*Amblychila cylindriformis* Say), which we herewith illustrate (Fig. 52) and which may be called the Cylindrical Tiger-beetle. It is of a tolerably uniform deep chestnut-brown color, and till quite recently was considered a great rarity; indeed, the *facile princeps* among beetles. Unlike the typical members of its family, this beetle is nocturnal and rather slow in its movements. Mr. S. W. Williston, of Yale, who captured large numbers last summer, wrote us from Monument, Wallace County, Kans., May 17, as follows, regarding its habits:

I have collected the beetle for several seasons, and have watched its habits. These are almost precisely the same as in *Omus*. Their movements are much more sluggish than *Tetracha* or *Cicindela*. They rarely destroy living insects of any kind, but feed mostly upon effect matter, dead insects, and such live ones as they can capture.

They cannot run as fast as the slowest *Cicindela*, and pay no attention to a collector till his fingers touch them.

Prof. F. H. Snow, of Lawrence, Kans., who made some observations for us last summer in the western part of his State, and who also succeeded in capturing many specimens, gives the following more complete account, in a paper read before the Kansas Academy of Science:

I was disappointed to find these insects apparently devoid of that intensely ferocious nature which had been ascribed to them by sensational writers for the Eastern press, and which would be suggested by its position at the head of a ravenous family, the *Cincindelidæ*, or Tiger-beetles. I have watched them night after night coming forth from their hiding-places soon after sundown and beginning their night-long search for food. I am satisfied that their sense of sight must be exceedingly deficient, as they never discover their prey from a distance, however slight, and never capture it unless stumbling upon it as if by accident. When, however, they do thus stumble upon an unfortunate caterpillar, grasshopper, or other suitable article of food, a very acute sense of touch, chiefly concentrated in their long and constantly vibrating antennæ, enables them to seize upon and firmly hold it with their powerful mandibles, while with their maxillæ, or secondary jaws, they withdraw the life-juices and soft tissues of their struggling victim. They also manifest the imperfection of their vision by making no attempt to escape from their human captors, allowing themselves to be picked up as if entirely blind. They are slow in their movements, walking about with great deliberation over their favorite hunting-grounds, the sloping clay banks. The only

approach to rapidity of movement observed during the summer was in the case of a single individual suddenly surprised by the morning sun while at a distance from a suitable hiding-place which he was making frantic exertions to discover.

In a brief paper contributed to this Academy by Mr. H. A. Brous, at our last annual meeting, it was stated that *Amblychilæ* live in holes which they construct for themselves. My own observations do not corroborate this statement. On the other hand, I found them invariably coming forth at night from holes made by other animals, most especially from the intricately winding burrows of the kangaroo rat (*Dipodomys phillippii*), by which the clay banks are often completely honey-combed. In these burrows they take refuge from the direct rays of the sun in the daytime, in company with other nocturnal genera—*Eleodes*, *Pasimachus*, &c. These latter insects undoubtedly furnish many a midday meal for *Amblychilæ*, which are not to be supposed to pass the entire day in sleep. On one occasion I had an opportunity of watching two of them in a large abandoned badger's hole. They were wide awake, and walking about with vibrating antennæ, as if in search of food. I have also kept several living specimens in confinement, and have carefully watched them for several weeks, but never discovered any disposition to make excavations for themselves, though they would gladly take possession of holes made for them in the earth at the bottom of the cage.

In regard to food, no living insect seems to come amiss to them. They seem to be especially fond of all sorts of Orthopterous and Lepidopterous larvæ. They will attack and devour the huge wingless locusts (*Brachypeplus*) and sword-bearers (*Ensicaudes*). I have seen them in the act of conquering and devouring the large *Prionus* of the plains (*P. fissicornis*), and in two instances have seen them eating one another, apparently with the keenest relish. In confinement they will thrive upon full-grown maple-worms (*Dryocampa rubicunda* var. *alba*), the caterpillars of the Handmaid Moth (*Datana ministra*), and almost every other insect pest of the orchard and garden.

We have ourselves kept a living specimen, sent us by Professor Snow, in a vivarium all through the past autumn and winter. It showed an admirable capacity for burrowing, and doubtless excavates its own burrows where those of other animals are not at hand to occupy. Our specimen devoured at first at the rate of two locusts a day, but subsequently became much less ravenous. It ate at night when the locusts were least active, and generally remained quiet and hidden in its burrow during the day.

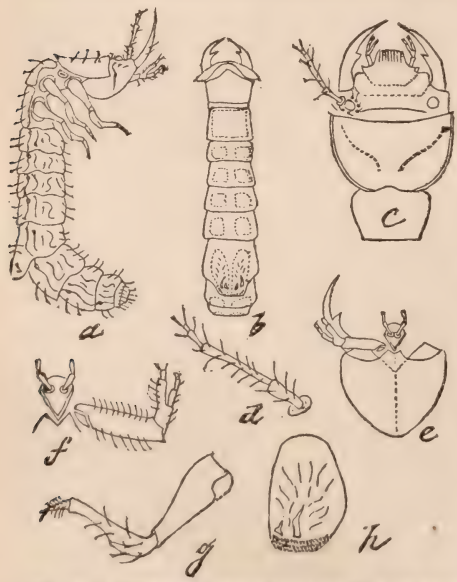

FIG. 53.—AMBLYCHILA CYLINDRIFORMIS.—*a*, larva, lateral view; *b*, same, dorsal view; *c*, head, prothorax, and mesothorax; *d*, antenna; *e*, head beneath; *f*, mentum and maxilla; *g*, leg; *h*, hook-bearing hump of joint 8. (After Horn.)

The larva (Fig. 53) of this species lives in a large cylindrical hole, from one to three feet deep, made in dry clayey banks; and Mr. E. W. Guild, in a letter to Dr. G. H. Horn, of Philadelphia, thus describes its habits:

The burrows are found in all gradations of surface, from a perfect level to a nearly vertical face, but are in greatest numbers in slopes of about 30°. They are very notice-

able from their large size and occurrence in clusters. Dry clayey banks are preferred and all the burrows I have examined enter at right angles to the surface of the soil, and remain straight for three-fourths of their length, then gradually curving. It is not unusual to see the larvæ after sundown, or earlier if the day be cloudy. They are, however, very shy, and I know of but one specimen being taken without considerable digging.

A full description of this larva by Dr. Horn will appear in vol. vii of the Transactions of the American Entomological Society, and we present the accompanying figure thereof, with its several parts enlarged, from an advance plate kindly furnished by the author. This larva had previously been mentioned (Ann. Lyc. iv, 1845, p. 143) by Dr. LeConte as that of *Pasimachus*.

Asilus-flies.—We have already referred to these flies (p. 303), the larvæ of some of which prey upon the eggs of the locust. The perfect flies are very fond of the young locusts, pouncing upon and seizing them, and then flying off to some spot where, unmolested, they can suck the juices of their victim.

FIG. 54.—PROCTOCANTHUS MILBERTI. (After Riley.)

Mr. Lawrence Bruner, of Omaha, Nebr., who has had good opportunity of observing, says that the larger species live almost entirely on locusts during the months of June, July, and August. Most of the larger species[76] doubtless have this habit, and one of the most common and ferocious in which we have observed it is the *Proctocanthus milberti*[77] Macq. (Fig. 54), and popularly called the Missouri Bee-killer, on account of its habit of destroying bees in the Southwest. These insects fly with a buzzing noise, and have a sufficiently powerful beak to produce quite a severe sting on the human hand.

Digger-wasps.—These insects by means of their powerful jaws

FIG. 55.—LARRADA SEMIRUFA.—Female. (Emerton *del.*)

FIG. 56.—LARRADA SEMIRUFA.—Female, grasping a young locust. (Emerton *del.*)

[76] Mr. Brous found the following species feeding on *spretus*: *Stenopogon consanguineus* Loew, a species with pale yellowish hairs on head and thorax, yellowish-brown wings, and pale rufous legs and abdomen; *Promachus apivora* Fitch; *Erax bastardii* (Fig. 29); several allied species of *Erax*, and a species of *Tolmerus*.

[77] The *Asilus missouriensis* Riley, 2d Mo. Ent. Rep. p. 122.

and spinous legs burrow with great rapidity in the ground, where they form a sort of nest; provision it with some kind of prey which they have stung and paralyzed; lay an egg thereunder, and cover up the hole—the larva when it hatches feeding upon the stored food thus provided by the parent. Several species have long been known to capture locusts and green grasshoppers. We noticed a small black species (*Prionony x atrata*, St. Farg.) that is quite common in Colorado, pursuing and capturing the pupa of *C. spretus*, and Mr. Packard caught a still smaller species (*Larrada semirufa*, Cress., Figs. 55, 56), with black head and thorax and reddish abdomen, while it was in the act of carrying a *spretus* larva. One of our handsomest species (*Sphex ichneumonea* L., Fig. 57), with golden pubescence on head and thorax and with the legs and basal half of abdomen rust-red, has been closely observed by Mr. Packard, and we copy the following account of its habits from his *Guide to the Study of Insects* (p. 167):

FIG. 57.—SPHEX ICHNEUMONEA. (After Emerton.)

In the last week of July, and during August and early in September, we noticed nearly a dozen of these wasps busily engaged in digging their holes in a gravelly walk. In previous seasons they were more numerous, burrowing into grassy banks near the walk. The holes were four to six inches deep. In beginning the hole, the wasp dragged away with its teeth a stone one-half as large as itself to a distance of eight inches from the hole, while it pushed away others with its head. In beginning its burrow it used its large and powerful jaws almost entirely, digging into the depth of an inch in five minutes, completing its hole in about half an hour. After having inserted its head into the hole, where it loosened the earth with its jaws and threw it out of the hole with its jaws and fore legs, it would retreat backward and push the dirt still farther back from the mouth of the cell with its hind legs. In cases where the farther progress of the work was stopped by a stone too large for the wasp to remove or dig around, it would abandon it and begin a new hole. Just as soon as it reached the required depth, the wasp flew a few feet to an adjoining bank, and falling upon an *Orchelimum vulgare* or *O. gracile* (two common grass-green catydid-like grasshoppers, about an inch long), stung and paralyzed it instantly, bore it to its nest, and was out of sight in a moment, and while in the bottom of its hole must have deposited its egg in its victim. Reappearing, it began to draw the sand back into the hole, scratching it in quite briskly by means of its spiny fore tarsi, while standing on its two hind pairs of legs. It thus threw in half an inch of dirt upon the grasshopper and then flew off. In this way one *Sphex* will make two or three such holes in one afternoon. The walk was hard and composed of a coarse sea-gravel, and the rapidity with which the wasp worked her way in with tooth and nail was marvelous.

A steel-blue species (*Chlorion cæruleum* Drury, Fig. 58), though ordinarily using spiders, also employs locusts; and the following extract from

a letter from Mr. William H. Edwards, of Coalburgh, W. Va., gives an interesting instance of this insect losing its way and being puzzled:

I was greatly entertained one day at seeing this steel-blue dirt-digger ride a locust up and down the walk of my garden in search of its hole, which it had missed by 20 feet, the hole being in fact in a walk parallel and similar to the one it was on, but 20 feet away. The wasp would ride up and down, stop, turn back, or drop the 'hopper and run about; then mount its prey again, until it found out its mistake by getting at last on to the proper walk.

FIG. 58.—CHLORION CŒRULEUM. (After Riley.)

Mr. A. N. Godfrey, one of our assistants, observed this wasp sting a pupa of *spretus* and bury it, and upon digging up the pupa found the wasp egg at the juncture of the hind femur with the body. Species of the genus *Scolia* are also known to have this same habit.

Tachina-flies.—The animals so far treated of as attacking the locust either devour it bodily, suck its juices, or are parasitic upon it externally. There remain those which prey upon it internally, and which in time exhaust and kill it. The most common of these are the larvæ of certain flies belonging to the genus *Tachina*—gray-colored, two-winged flies, having very much the general appearance of the common house-fly, though usually somewhat larger.

"These Tachina-flies firmly fasten their eggs—which are oval, white, and opaque, and quite tough—to those parts of the body not easily reached by the jaws and legs of their victim, and thus prevent the egg from being detached. The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them, haunted by a Tachina-fly, will make to evade its enemy. The fly buzzes around, waiting her opportunity, and when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily, she has even greater difficulty; but though the locust tacks suddenly in all directions in its efforts to avoid her, she circles close around it and generally succeeds in accomplishing her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or a hop. The young maggots hatching from these eggs eat into the body of the locust, and after rioting on the fatty parts of the body—leaving the more vital parts untouched—they issue and burrow in the ground, where they contract to brown, egg-like puparia, from which the fly issues either the same season or not till the following spring. A locust infested with this parasite is more lan-

FIG. 59.—YELLOW-TAILED TACHINA-FLY. (After Riley.)

guid than it otherwise would be; yet it seldom dies till the maggots have left. Often in pulling off the wings of such as were hopping about, the bodies have presented the appearance of a mere shell filled with maggots; and so efficient is this parasite that the ground in parts of the Western States is often covered with the Rocky Mountain locust dead and dying from this cause.

"Mr. Byers, in speaking of the locusts hatching in Colorado in 1865, says: 'That upon attaining about half their full size, they were attacked by a fly, which, stinging them in the back between the roots of the wings, deposited one or more eggs, which produced a large white maggot. The worm subsisted upon the grasshopper, finally causing its death, when it cut its way out and entered the earth. In this way probably half were destroyed, often covering the ground, and filling the furrows in plowed fields with their carcasses. The remainder, when their wings were sufficiently developed, took to flight, moving southeast, and we lost trace of them on the great plains.'

"Mr. S. E. Wilber, of Greeley, Colo., has published an account of what is evidently the same fly.[78] In this account, after showing how persistently the fly pursues the locust—leaving it no rest, and so effectually weakening whole swarms as to render them harmless—he expresses the opinion that the constant importunities and annoyances of this fly are the cause of locust migrations." We have already expressed our belief that at times they may prove one of the immediate causes.

Persons who have not lived in the West, where the locust has prevailed, can form no idea of the great abundance of these Tachina-flies. We found them buzzing about so numerously in the mountain regions last summer as to prove a positive nuisance to travelers, and every locust as it attempted to fly was pursued by several. It was also very generally conceded, especially in Colorado, that one of the principal reasons why the locusts did so little damage in 1877 was because they were so generally infested with Tachina maggots. We found the same state of things wherever we went in the Northwest, and in 1875 in parts of Manitoba, as we were credibly informed by Mr. W. F. Luxton and others, they so effectually killed off the young locusts that none matured to fly off. In Minnesota they were so numerous as to follow the locusts in vast swarms. Mr. J. I. Salter, of Stearns County, having communicated the fact of vast clouds of flies passing over Todd County, we wrote to ascertain the kind, and received the following account:

As to the flies, they were the fly described in your bulletin as the Tachina-fly. Some two or three weeks before the final flight of the 'hoppers I noticed thousands of those flies on my timothy and clover meadow, where the locusts were in great numbers, and noticed that these seemed to be in fear, restless, and uneasy. I found, by watching, that they had cause to be, for no sooner would one take wing, or even hop, but it would be attacked by those flies. Finally, the locusts rose *en masse* and left, and shortly after (I have now forgotten how soon) the flies left in a cloud or swarm, nearly all. I saw the locusts leave; also the flies. Then about the last flights of locusts, going

[78] Popular Science Monthly, iv, p. 745.

southeast, or shortly after, I saw at two different times, on different days, flights of what I believed, and still believe, were the same flies before spoken of. My neighbor, Donald McIntosh, also saw one, if not more, swarms of the flies, apparently following the locusts. In every instance they took the same course as the locusts.

In warm weather, these flies multiply very rapidly, undergoing all their transformations in the course of a fortnight from leaving the egg; but in the cooler seasons the pupal development under ground is much slower, and the winter is generally passed in the puparium, though we have known the larvæ to remain in the ground unchanged all through the winter.

The following extracts, principally from our correspondence, refer to these Tachina-flies, and very well indicate the effectual work they sometimes perform:

Also, I will say that the grasshoppers, which a month since seriously threatened to devour every green thing, have met with a mortal foe and been slain by millions. (Don't think "millions" too large a word.) Very few have taken to "themselves wings and flown away," as heretofore, but lie dead in the fields they lately ravaged. A small fly pierces them and deposits an egg *while on the wing* (or on the jump), and, like Herod of old, "they are eaten of worms and give up the ghost."—[Jos. C. Shattuck, Greeley, Colo., July 14, 1873.

It seems that the grasshoppers that are so destructive to vegetation in many places in the central portion of the continent are likely to find an enemy which threatens their rapid destruction. The *Deer Lodge Independent* says that a fly has made its appearance, closely resembling the common house-fly, but much larger, and of a gray, mottled color, which deposits its eggs under the wings of the grasshopper. The egg is inclosed in a glutinous substance, which secures it in its position until the worm is matured [embryon developed]. It then penetrates the body of the grasshopper, which speedily dies. The worm then burrows in the ground, and at the end of seventeen days comes forth a fly, ready to again commence the work of destruction. Mr. William Walker, of Dempsey Creek, informs the Independent that twice during the past summer the grasshoppers threatened to destroy his crops, but the flies killed them so rapidly that they did him but little damage. As the grasshoppers were killed before depositing their eggs, it is generally believed that this plague is ended in the Deer Lodge Valley.—[Published in several Montana papers in the summer of 1874.

A great many of the locusts seemed to be punctured on the back, and on pulling their heads off after death (many were found dead) from one to three ordinary-looking maggots would be found. Many farmers fear it might be an introduction of a new plague. May not this gentleman with his little gimlet in time prove the destroyer of the hateful locust?—[R. P. C. Wilson, Platte City, Mo.

I saw a 'hopper kicking about as if he could hardly move; I pulled him to pieces and found that he contained a footless grub half an inch in length. In a short time more were procured, placed in a covered tumbler, where, in a little more than two weeks, the grubs changed to Tachina-flies, very much resembling the common house-flies. * * * When we remember what an enormous number of eggs (fly-blows) a fly will lay, and that each, in about a month, will be a perfect fly, it is seen that it would take but a few generations to clean out an army of grasshoppers.—[Oscar J. Strong, Rolfe, Pocahontas County, Iowa, in *Western Farmer*, February, 1869.

Two years ago there was a fly that stung the locust when about half-grown, and killed large numbers. The fly laid an egg that soon developed into a maggot that ate out the inside of the locust, leaving only a shell. I gathered some of the maggots while they were within the locust, and put them in a glass. In about four days they went into the pupa state, looking something like a kernel of rye, but a little more plump,

and in about ten days they hatched out into a fly about the size and appearance of the house-fly.—[C. O. Perkins, Oswego, Labette County, Kansas, June, 1877.

Very many have been killed by a large maggot, apparently the larva of a *Sarcophaga carnaria*. The maggot is about one-fourth of an inch in length. They seem to attack the locusts at or near the time of the last molt, though sometimes the pupæ are attacked. The locusts, when affected, become torpid, and hop with difficulty. When these are examined, one or more maggots are found at work in the thorax. After the locust is killed, the maggots continue at work until every particle of the viscera is consumed, leaving only the empty skeleton remaining. One dead locust was found to contain *eight* of the fully-grown maggots.—[A. N. Godfrey, June, 1877.

Myriads of locusts were destroyed by cold, heavy rains, and by a small fly producing maggots in them. Flies of this kind very numerous.—[James Moore, Bastrop, Tex., May 8, 1877.

Upon examination of the young 'hoppers we find several very small-looking worms, which seem to develop with the 'hopper, and when it (the 'hopper) gets a little older this worm seems to have increased in size so much until we find them eating their passage out of the 'hopper, after which the 'hopper dies in a very short time. When it comes out it looks something like a maggot from a dead carcass. We find from three to six of these worms in a 'hopper, and, as before stated, the 'hopper very soon dies after this worm is out, and it was the immense number of the dead 'hoppers on the prairies that led to the discovery of the phenomena described. It being an entire new feature here makes us somewhat interested, especially as we hear the report of dead 'hoppers from various portions of the State. Some time after leaving the 'hoppers, this maggot (or whatever it may be) burrows into the ground, and this is as far as we know anything of it at present; when it goes into the ground it has attained a size of about one-quarter of an inch in length and very thick in proportion, and somewhat ribbed as it contracts and expands in moving. My object in writing you is to get your opinion as to what this worm may turn to, as some here think it will produce more 'hoppers, others think some kind of a fly. There is one thing certain, if they keep on at the present rate of destruction the 'hoppers will be a scarce animal in a couple of weeks. We shall be pleased to have a reply from you on this subject, as it may benefit a suffering community.—[A. W. Risien, Groesbeck, Tex., April 25, 1877.

Some time since "Will," our special correspondent, gave our readers an account of the wonderful destruction of grasshoppers by the Tachina-fly in the Bitter Root country. We notice that his statements of the investigation are corroborated by Professor Riley in his new book. But his investigations went still further than Professor Riley's. He estimated these flies produce from 70 to 100 maggots each. These maggots, after devouring the 'hopper, burrow into the earth, but the question is not yet settled as to when the fly issues from it. Professor Riley says: "They issue and burrow in the ground, where they contract to a brown, egg-like pupa, from which the fly issues, either in the same season or not until the following spring." Mr. J. L. Humble, of Bitter Root, who is aiding us in the investigation, writes under date of August 21:

"Agreeably to promise, I write to inform you of the results of my experiments with the grasshopper and his natural enemy—the fly. I saw flies sting a number of 'hoppers (6), and caught them and put them under a glass vase. In twenty-four hours from the time they were stung, the worm had entered the body of the grasshopper; and in twelve hours more (doubtless the 'hopper thought it an age), the grasshopper yielded the last spark of vitality to the uncompromising greed of his internal foe."

Now, if these flies destroy from 70 to 100 'hoppers during their lifetime, killing the 'hopper in 36 hours from the time the eggs are laid, and a new fly issues therefrom, we have grounds for a hope that the plague may eventually be destroyed, or so greatly diminished that the ravages will not be felt.—[*Rocky Mountain Husbandman*, Diamond City, Montana, September 6, 1877.

There are a few left now, but they seem very weak, and many I find dead; and on examining them find a worm which eats the inside of the 'hopper and leaves only a shell.—[Stephen Bradley, Agenda, Kans., July 12, 1877.

In 1869 large numbers of the grasshoppers were destroyed by a parasite eating their vitals. It comes from an egg deposited by a blackish fly. Many have died from the same cause this year.—[Jas. S. Cantwell, Smithfield, Cache County, Utah.

On the 24th ultimo I first noticed that the 'hoppers were getting wings, and now four-fifths of them are winged. A great number of them are dying from the effects of a grub or maggot which devours the inside of the 'hopper, leaving but little more than the shell.—[W. J. Newell, Athol, Iowa, July 2, 1877.

There are doubtless many different species of these Tachina-flies that attack our locusts, but by far the most common is the Anonymous Tachina-fly (*T. anonyma* Riley), which attacks also a large number of other insects.[79] The Yellow-tailed Tachina-fly (*Exorista flavicauda* Riley, Fig. 59), which more particularly attacks the army-worm, will serve to illustrate these insects.

Flesh-flies.—These flies also attack the locust. They greatly resemble the preceding in general appearance, but may be distinguished by the style of the antennæ being hairy instead of smooth. Judging from the accounts of correspondents, and the well-known habit of breeding in dead and decomposing animal matter which these flies possess, they are most attracted to those locusts that are feeble or already dead, and are fond of laying their eggs on specimens which have just molted, and are yet pale, soft, and helpless.

FIG. 60.—SARCOPHAGA CARNARIA; greatly enlarged. (After Emerton.)

FIG. 61.—SARCOPHAGA CARNARIA—puparium; greatly enlarged. (After Emerton.)

These flies lay elongate and delicate eggs, which hatch very quickly. They sometimes hatch, in fact, within the oviduct, so that the fly gives birth to living larvæ. These are distinguished from those of the Tachina-flies by being more concave and truncated at the posterior end (see Fig. 62, *b*). The Tachina larva is rounded posteriorly, with a small spiracular cavity, easily closed, and having a smooth rim; it contracts to a pupa, which is quite uniformly rounded at each end. The Sarcophaga larva is more truncate behind, with fleshy warts on the rim of the spiracular cavity, and with a more tapering head; it contracts to a pupa, which is also truncate behind, and more tapering in front, where the prothoracic spiracles show as they never do in Tachina.

[79] See Mo. Ent. Repts. 4, p. 129; 5, p. 133.

The species most commonly infesting our locust is the common Flesh-fly (*Sarcophaga carnaria* L.), a wide-spread species and general scavenger, common alike to Europe, America, and Australia, and probably to other quarters of the globe. Its larvæ infest different kinds of locusts and the common Mantis;* and they generally leave nothing but the bare shell of their victim. They develop very rapidly; and, like the Tachina maggots, burrow in the ground to go through their transformations. The accompanying figure of a variety (*sarraceniæ* Riley), which feeds on the dead insects caught in those curious traps, the Trumpet-leaves (genus *Sarracenia*), will serve to illustrate these transformations.

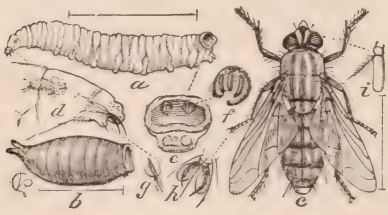

FIG. 62.—SARCOPHAGA CARNARIA var. SARRACENIÆ.—*a*, larva; *b*, pupa; *c*, fly, the hair-lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*) and prothoracic spiracles; *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*, tarsal claws of fly, with protecting pads; *i*, antennæ of same—enlarged. (After Riley.)

Another species that attacks the Rocky Mountain locust is the *Calliphora erythrocephala*, Meig., also very common and wide spread, and easily distinguished from the preceding by its blue color. The following extracts refer to these flies:

A certain blue or green fly has been more largely instrumental in destroying the insects than any other cause, so far as known. They operated by depositing an egg or eggs about the junction of the thorax with the abdomen, which produced a worm that destroyed life in a short time. They were most active about the time of the second molting. A few specimens of the flies (found dead) are forwarded. I also saw a small spider destroy one, but cannot say whether many were killed in that way.—[Daniel Parker, Calvert, Tex., April 26, 1877.

During the summer I noticed that many of the large yellow grasshoppers (*Caloptenus differentialis*) were infested by the maggot of a species of fly very nearly resembling, if not identical with, the common Flesh-fly (*Sarcophaga carnaria*). Many of the grasshoppers were almost completely eaten out when found, retaining just sufficient strength to hop feebly ever the ground. I estimate that this particular species of grasshopper was diminished in numbers at least one-tenth, possibly one-eighth, by these new friends. It is to be hoped that these new parasites will increase rapidly. Professor C. V. Riley informs me that the Migratory Locust (*Caloptenus spretus*) is also infested by a similar one. Thus far, however, I have failed to detect any in the specimens collected in this vicinity.—[Professor C. E. Bessey, Ames, Iowa.

As the young locusts began marching, swarms of green and blue flies made their appearance, and seemed to accompany them. I soon found numbers of young locusts dead with maggots in them, and supposed the flies were following them to blow those accidentally killed, but during the second molt I discovered the locusts were very tender and helpless, and I observed these flies watching them and alighting on them as they came out of their casts. Catching one which I had observed attacked by the fly, I found half a dozen live maggots busily engaged eating his entrails. By patient watching, I found that those attacked by the fly would die in from five to ten minutes; and the maggots, after finishing them, would disappear in the ground, and I suppose, in the course of time, comes out a new fly.—[W. L. Coleman, Calvert, Tex., April 24, 1877.

Ichneumon-flies.—It is an interesting fact that not a single Ichneumon-fly is positively known to attack our locust, nor has one ever been found

*Locust Plague, etc., p. 136.

to attack any of the different locusts or grasshoppers that occur in the country. We have sought diligently for evidence of the occurrence in locusts of any of these essentially parasitic insects. By Ichneumon-flies we intend, not those of the genus *Ichneumon* alone, but any belonging to the great family *Ichneumonidæ*. They are known to attack plant-feeding species of all Orders except the Half-winged bugs (*Heteroptera*) and the Straight-winged insects (*Orthoptera*), to which last the locust belongs. Westwood, St. Fargeau, Brullé, and other authors who have paid especial attention to these Ichneumon-flies, all concur in excepting the Orthoptera from their attacks. Von Motschulsky speaks of having found a species (*Proctotrupes brevipennis*, Latr.) of an allied family near Italian locusts, and infers, without proof whatever, its possible parasitism thereon; but, of the latest and most reliable European authorities, Gerstäcker and Köppen, the former states explicitly that no Ichneumon is known to attack the European locust, while the latter knows of none, and refers only to rumors of the occurrence of bee-like insects that sting the locust, and which rumors doubtless have reference to Digger-wasps or Tachina-flies. Again, Mr. Thomas Bath,[81] in treating of the injuries of locusts in Australia, one species of which (given as *Œdipoda musica*, Fabr.) in size and general appearance is not unlike our *spretus*, figures an Ichneumon-fly (given as *Bracon capitata*) stinging a locust, and certain maggots, supposed to be the larvæ of the same, taken from a locust. But the former is imaginary, unreal, and evidently not from actual observation, while the latter are evidently the larvæ, not of an Ichneumon, but of some Dipterous (doubtless *Tachina*) fly. Coming to our own country, Mr. Brous, in 1876, sent us two Ichneumons—a *Campoplex* and *Pimpla notanda*, Cresson—noticed flying about locusts, but without evidence of their stinging these; and Professor Aughey has sent us a female *Lampronota brunnea*, Cresson, which he believes to have bred from winged specimens of *spretus* in August, 1874. But his notes lack in absolute certainty, and he himself has on that account refrained from referring to the supposed fact; while the long ovipositor and well-known habit of some species of the genus of preying on wood-boring Coleopterous larvæ, to reach which the ovipositor is admirably adapted, strengthen the uncertainty, and render further corroborative evidence necessary before we can say that any Ichneumon-fly actually preys on the Rocky Mountain locust.

Reports from farmers, of Ichneumon-flies attacking locusts, are not uncommon, because this term is often erroneously applied to any parasite, and especially to the Tachina-flies and the Anthomyia egg-parasite, already treated of. Some writers have even sought to justify its application to this last species, on the ground that the term "ichneumon" means an egg-feeder; unaware of the fact that it has a definite meaning in entomology, and that, while originally applied by Aristotle to an Egyp-

[81] "Notes on Observations made during the Late Locust Plague." Report of the Secretary for Agriculture, Melbourne, 1873.

tian animal (*Herpestes ichneumon*, L.) that hunts for and feeds on crocodile eggs, it was also applied, both by Pliny and Aristotle, to a wasp that hunts spiders and caterpillars, for which reason Linnæus appropriately used it to designate the parasitic family we have been considering.

Hair-worms.—Of all the different enemies of our locust, these long, thread-like worms are the most curious and remarkable. Occurring in all parts of the world, and mentioned even by Aristotle, they are by no means rare. We have on several occasions obtained specimens from *spretus*, and a number of our correspondents have reported the locusts affected by them. Mr. I. G. McGrue, of Audubon, Minn., even asserts that in that part of the country the hair-worms destroyed as many locusts, in 1875, as did any other enemy. The locust infested with one of these worms may be recognized by its pale and sickly look, and especially by the want of color on the hind thighs. The worms are not infrequently found within the young and unfledged locusts, but far more often noticed within or issuing from the winged individuals. Ordinarily there is but one worm, but as many as five have been found, within a single locust. If we carefully detach the head of a full-grown locust infested with one of these parasites, just before it would naturally issue, we shall find the coiled ends thereof protruding from the thorax, and the rest of the animal coiled up longitudinally around the intestines and among the viscera, the muscular, secretory, and reproductive organs of the locust being much wasted, and the worm so closely pressed against or coiled around them as to almost completely occupy the whole inside of the poor locust, from the head to the anus, through which last the parasite eventually issues.

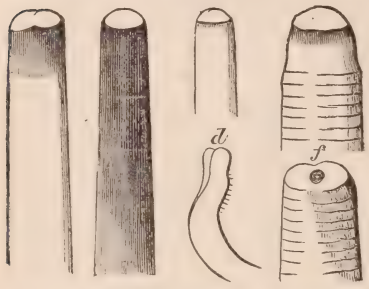

FIG. 63.—HAIR-WORMS.—*a*, anterior extremity of the female Variable Gordius (*G. varius*); *b*, the same of the male; *c*, anterior extremity of the Linear Gordius (*G. linearis*); *d*, side view of the posterior extremity of the male of the same species; *e*, anterior extremity of the Robust Gordius (*G. robustus*) from Kansas; *f*, posterior extremity of the female of the same species, exhibiting the genital pore (after Leidy).

These hair-worms are not only very frequently found in different locusts, grasshoppers, katydids, and crickets, but Professor Leidy even has one from a cockroach. They likewise occur in many other insects and smaller animals, as beetles, moths and butterflies, bees, two-winged flies, spiders, and snails.* As a rule, the worms forsake Lepidoptera while these are in the larva state, or, more rarely, in the pupa state; whereas they generally issue from Coleoptera and Orthoptera only after these have acquired the perfect state. They belong to two different genera, *Gordius* and *Mermis*, differing more in internal structure than in

*Siebold (Ent. Zeit., Stettin, ix, 1848, pp. 295–300; xi, 1850, pp. 332–336) gives a list of Articulates found infested with hair-worms up to that time, from which it appears that insects of all Orders except Neuroptera are attacked, while even mites are probably infested.

external appearance. The commoner species of the former genus are brown, while those of the latter are white or pale yellow. In reality, some of those which are pale while within their host become dark after issuance, and the color alone has no generic value. We need hardly allude here to the popular belief that these worms are animated horse-hairs. Despite the ready explosion of the fallacy by naturalists, the superstition is yet very prevalent, and we have several otherwise intelligent correspondents who persist in the popular faith. The development of these Entozoa is, indeed, so obscure and difficult to trace that their life-history is yet enshrouded in some degree of mystery, a fact which has no little to do with the perpetuity of the popular delusion. So far as present knowledge permits, let us glance at this curious life-history. In the *American Entomologist and Botanist* for May, 1870, Prof. Joseph Leidy, of Philadelphia, published what was then known of these worms, and we quote here some of his remarks. We are also indebted to Professor Leidy for a critical examination and determination of the specimens we have studied.[83] An interesting fact is worthy of mention here, as it may be more than mere coincidence: it is that all the Orthoptera infested with these parasites that have come under Mr. Riley's notice (9 in number) are females.

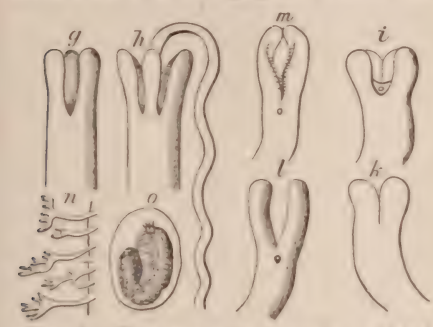

FIG. 64.—HAIR-WORMS.—*g*, posterior, tri-lobed extremity of the female Variable Gordius; *h*, the same, with the lobes more divergent, and exhibiting the extrusion of the cord of eggs; *i*, posterior bi-lobed extremity of the male Variable Gordius, seen on the ventral surface, and exhibiting the genital pore; *k*, dorsal view of the same; *l*, posterior bi-lobed extremity of the male Long-lobed Gordius, seen on the ventral surface, and exhibiting the genital pore; *m*, the same in the male of the Linear Gordius; *n*, portion of the fringe of the latter, highly magnified; *o*, egg of the Variable Gordius, containing a fully developed embryo highly magnified. (After Leidy.)

The Hair-worm is, however, a distinct animal, having no further relationship with a horse-hair than in its general likeness, which is by no means an exact one. When

[83] The following specimens of hair-worms have been found infesting locusts, grasshoppers, katydids, and crickets:

Gordius setu, Müller (*aquaticus* of other authors).—Two specimens (♂ ♀) from a ♀ *Phyllopteru oblongifolia* (De Geer). The ♂ has the dark annulus and pale truncated end, and also the anal bifid characters of *G. varius* Leidy; but the ♀ has not the trifid anal characters of that species, and approaches *robustus*. Color light coffee-brown. Length of ♂ 8½ inches; diameter 0.8 mm.; length of ♀ 10¼ inches; diameter 0.9 mm. One ♂ from a ♀ *Orchelimum glaberrimum*; one ♀ also from a ♀ *Caloptenus spretus*. All the above in Mr. Riley's cabinet. Specimens of the same from water often show a transverse capital carina in the ♀, and a dark longitudinal line the whole length of body. Mr. Packard has a ♂ taken from *Gryllus neglectus*, and has observed two specimens of what was apparently the same species in *Caloptenus bivittatus*.

Gordius robustus, Leidy.—A ♂ from ♀ *Anabrus purpurascens* Uhler; in Mr. Riley's cabinet. Length 11½ inches; diameter 0.9 mm. Very similar to ♂ of preceding species, though the transverse striæ are more distinct. Diesing refers it to *aquaticus*, and it doubtless is specifically the same. Packard records a ♀ from *Stenopelmata fasciata*, Thomas, taken at Wahsatch, Utah, and Leidy records a ♀ from *Orchelimum gracile*.

Mermis albicans.—Two specimens from ♀ *Caloptenus spretus*, one 17 the other 11 inches long; diameter 0.6 mm. Anterior end quite tapering; neither capital nor anal characters that are noticeable. One very long specimen, measuring 30 inches, from a *Lycosa*. One, evidently the same, but incomplete, from a ♀ *Stenobothrus*; and one from a ♀ *Caloptenus differentialis*. All in Mr. Riley's cabinet.

Mermis acuminata, Siebold.—This species, according to European authors (Siebold, Meissner, and Diesing), is but the parasitic non-sexual condition of *M. albicans*, which they consider the external fertile or sexual condition. Both forms are, however, parasitic. Mr. Riley has two specimens from a ♀ *Acridium americanum* in the pupa state, one of them measuring 16, and the other 11½ inches; also one specimen, 4½ inches long, from a ♀ *Caloptenus spretus*; also five specimens from the larva of *Carpocapsa pomonella*, varying from 3 to 8 inches in length. A specimen of what was doubtless the same species was seen by Professor Leidy protruding from *Œdipoda carolina* while the latter was struggling in a ditch.

sought for in the proper places, as is the case with many other animals, the Hair-worm is much less rare than is generally supposed. In the latter part of summer or the beginning of autumn, in the search for the animal, I have frequently found it, while sauntering along the banks of a river or creek, in little hollows close to the shore. It requires some practice to discover it, as usually it is comparatively quiet in such situations, and may readily be confounded with the blackened, decomposing vegetable fibers occupying similar places. Sometimes it is found single, and at others a number are discovered coiled together in a loose but intricate-looking knotted mass. Such knots, which had passed through the water-pipes and issued at hydrants in our city, I have seen on two occasions. Similar knots, no doubt, were the source of the scientific name of the worm, that of Gordius, applied to it by Linnæus, from the fabled Gordian knot of antiquity. The Gordius, however, not only resembles the latter in the intricate condition into which it sometimes gets, but its history is yet in part a Gordian knot to be unraveled.

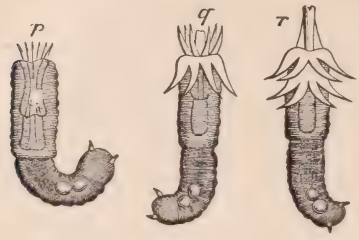

FIG. 65.—HAIR-WORMS.—The young Variable Gordius, after escaping from the egg, highly magnified; *p*, the worm commencing to protrude the oral apparatus; *q*, the first circle of hooklets bordering the collar reflected, and the protrusion of the second circle of hooklets and the style; *r*, complete protrusion of both circles of the hooklets and style. (After Leidy.)

The worm is perhaps the hardest or most resistant to the feel of any of its order, and it is tough and elastic. It is very tenacious of life, and when cut into several pieces will continue to live and move for some time afterwards.

Linnæus accepted a popular error in regard to the Gordius. In his System of Nature he says that, "if the worm is incautiously handled it will inflict a bite at the ends of the fingers, and occasion the complaint called a whitlow." It is sufficient to refute such a fancy when it is learned that the animal has neither jaws nor other instruments by which it could either bite or sting. * * *

Notwithstanding the simplicity of its outward form, its organization is of complex character, and certain of its peculiarities are of special interest to the physiologist. For jaws I suspect the forks of the tail of the male have been mistaken. Some European observers have failed to detect the mouth, though Dr. George Meissner, of Göttingen, a most accurate investigator, both describes and figures it. Sometimes, and indeed generally, I have detected the appearance of a minute orifice, or pore, to one side of the summit of the head in the Variable Gordius, but in other instances and in other species, including the large Robust Gordius of Kansas, I could distinguish nothing of the kind, the head end appearing as smooth as a watch-crystal, without the slightest sign of even a depression.

All reliable investigations, in addition to my own examinations, prove the total absence of anything like a stomach, intestinal canal and vent, in Gordius. The interior of the body is occupied by a soft, white matter, reminding one of the pith of sassafras or other plant. This matter consists of polyhedral cells, resembling vegetable cellular tissue, and forms a continuous mass from one end of the body to the other. Spaces included in this cellular tissue are occupied by the genital and other organs. According to Dr. Meissner, the mouth opens into a short gullet which expands upon the upper end of the mass of cellular tissue.

Nutritive liquid matter imbibed by the mouth, or the thin investment of the head end of the animal, it is evident, can only pass throughout the body of the latter by endosmosis from cell to cell of the interior cellular structure. The arrangement of the latter, and the transmission of nutritive liquid, reminds one of the organization and passage of liquids through the rootlets of a plant.

Nothing like a system of blood-vessels, or nutritive tubes, nor like the tracheal air-vessels of insects, can be detected in the structure of the worm.

Whilst parasitic in insects, the Gordius is bathed in a rich and highly aërated nutritive material, and would thus not appear to require either an apparatus for the ingestion of food nor one for respiration. Perhaps, too, on account of the absence of a digestive and respiratory apparatus, when the Gordius first escapes from its abundant provision of "aërated bread," it is stimulated to incessant activity in the water to fulfill at least its respiratory need.

The generative apparatus of the female consists of a pair of ovaries, contained in the interior cellular tissue of the body, extending the greater part of the length of the latter on each side, and conjoining in a common receptacle below, which terminates at the genital pore. In the male the testes hold a similar relationship, and terminate in like manner.

Of other interior organs, there is a tubular gland extending through the axis of the body, and a cylindrical cord, apparently muscular, extending along the ventral side.

The nervous system consists mainly of a cord, without distinct or separate ganglia, extending along the ventral side, between the muscular cord just indicated and the general envelope of the body. In the head the nervous cord divides on each side of the muscular cord, and, according to Dr. Meissner, becomes continuous with a ring surrounding the gullet. No eyes or other organs of special sense appear to exist.

The external integument of the body consists of a thin cuticle of pavement-like cells, and a thick dermis. This is composed of layers of fibers which pursue a spiral direction around the body of the worm, alternating or crossing in the successive layers. Within the thick skin of the worm there is a thicker muscular layer, composed of longitudinal fibers.

The Gordius is a wonderfully prolific animal. The mode of impregnation I have not observed. In the European *Gordius aquaticus*, Dr. Meissner observed that the tail end of the male wound spirally around that of the female, and by its forked extremity grasped that of the latter, while the genital pores were closely applied together.

The Variable Gordius and the Long-lobed Gordius extrude their eggs in a long, narrow white cord, from between the lobes of the tail, as represented in Fig. 64, *h*. I observed a Variable Gordius, 9 inches in length by 2-5ths of a line in thickness, commence laying eggs, and continue the process very slowly and gradually during two weeks. They were extruded in a delicate cylindrical cord, resembling a thread of sewing-cotton. At first it broke off, as extruded, in pieces about a foot in length, but, towards the end of the process, the cord appeared to be less tenacious, and broke off in pieces a few inches, and even a few lines, in length. The pieces in the aggregate measured 91 inches; the thickness of the cord was about the 1-10th of a line. The eggs are very minute, and in the cord were compressed together so as to be polyhedral. In a transverse section of the cord I counted about 70 eggs, and in the length of 1-40th of an inch 26 eggs, which, by calculation, gives 6,624,800 as the whole number of eggs in the cord. The eggs when isolated assume an oval shape, and measure about the 1-750th of an inch long by the 1-1000th of an inch broad.

The development of the young from the egg is readily observed from day to day; and it takes about a month before the process is completed. The globular mass of yolk in the center of the egg undergoes segmentation, and increases in bulk until it is finally resolved into an oval mass of granules, occupying the greater part of the interior of the egg. Gradually the mass assumes the appearance of a worm doubled upon itself, as seen in the magnified view (Fig. 64, *o*). In about four weeks the Gordius reaches maturity, and escapes from the egg totally different in appearance from the parent (Fig. 65, *p*, *q*, *r*).

The newly-developed Gordius is about the 1-450th of an inch long. The body is constricted just posterior to the middle, so as to appear divided into two portions, reminding one of the two divisions of the body in spiders. The anterior thicker portion of the body is cylindrical, distinctly annulated, and contains a complex apparatus which the animal is capable of protruding and withdrawing. The posterior part of the body is cylindrical, annulated, and rounded at the extremity, which is furnished with a pair

of minute hooks. The interior exhibits a faintly granular structure, including two large, clear, globular bodies.

The young Gordius appears not to be able to swim about, but lies at the bottom of the vessel containing it, slowly progressing through the alternate protrusion, reflection, and retraction of the oral apparatus, and occasionally swinging the hinder part of the body from side to side.

The oral apparatus consists of a collar, with two circles of hooks, six in each, and a proboscis-like style. In the movements of this apparatus, the ends of six hooks are seen to protrude from the center of the head (Fig. 65, *p*). These continue to project and diverge more and more, and then become reflected. As they turn backward, the ends of the second circle of hooks are observed protruding in the same manner, and then follows the style (Fig. 65, *q*). When the latter is fully protruded, the first circle of hooks is seen at the margin of a collar deeply reflected at the side of the body, while the second circle of hooks is reflected from the margin of the head (Fig. 65, *r*). In a reverse order the different parts of the apparatus are retracted, to be again protruded in the manner described.

The newly developed Gordii, under my observation, continued to live about a week more, and then gradually died.

Dr. Meissner was successful in following the history of the animal a step further. Having placed in the same vessel with the young Gordii a number of larvæ of May-flies (*Ephemeridæ*) and Caddice-flies (*Phryganeidæ*), he observed that they entered these insects, and thus commenced their parasitic life. The worms were observed to penetrate the delicate membrane at the joints of the legs of the insects, and gradually to advance among the muscles and other organs throughout the body. In some of the insects as many as forty of the young Gordii had penetrated. They afterwards became quiescent, doubled on themselves, and encysted, so as to resemble their former condition just before emerging from the egg. In this state they recall to mind the similar encysted Trichinæ in the muscles of man and the hog.

Dr. Meissner observed no further change in the Gordii, while contained in the insect larvæ, nor did he detect them after feeding some of the latter to Water-beetles.

Thus from the young Gordius, which has escaped from the egg and entered upon its parasitic life in the interior of insect larvæ, to the parent Gordius, as it is commonly observed, either as a parasite or living in the water, the circle of the animal's history is broken and unknown.

Perhaps the young Gordii remain quiescent in the May and Caddice-flies until these undergo their last transformation in the air, when they may be seized and devoured by Ground-beetles, which are ever lurking beneath stones and other objects in the vicinity of water on the lookout for prey. Once eaten by the beetles, like Trichinæ swallowed by the hog, the Gordii may then undergo transformation, and assume the form of the parent Gordius, which is said especially to infest the Ground-beetles.

M. A. Villot has, more recently,[81] added to our knowledge of the life-history of these curious creatures, as will be seen by the following account of his discoveries, condensed by Mr. Packard:

The eggs (Fig. 66, *a*) are laid in long chains; they are white, and excessively numerous. The yolk undergoes total segmentation (Fig. 66, *b*). At the close of this period, when the yolk is surrounded by a layer of cells, the germ elongates at what is destined to be the head-end, this layer pushes in, forming a cavity, and in this state it is called a "gastrula" (Fig. 66, *c*). By this time the embryo becomes pear-shaped (Fig. 66, *d*); then it elongates. Subsequently the internal organs of digestion are formed, together with three sets of stiff, spine-like appendages to the head, while the body is divided by cross-lines into segments. The head lies retracted within the body (Fig. 66, *e*).

In hatching, it pierces the egg-membrane by the aid of its cephalic armature and

[81] Monographie des Dragonneaux (Genre *Gordius* Dujardin), par A. Villot. (Archives de Zoologie expérimentale et générale, tome 3, Nos. 1, 2, 1874, Paris.)

escapes into the water, where it passes the early part of its life. Fig. 66, F, represents the embryo of *Gordius aquaticus* greatly magnified. It will be seen how greatly it differs from the adult hair-worm, having in this stage some resemblance to the *Acanthocephalus* by its cephalic armature, to the *Nematoidea*, or thread-worms, by its alimentary canal, and to the larvæ (*cercaria*) of the *Tremotodes*, or fluke-worms, in the nature of its secretory glands. But the hair-worm differs from all these worms and even *Mermis*, a hair-worm much like, and easily confounded with, *Gordius*, in having a complete metamorphosis after leaving the egg.

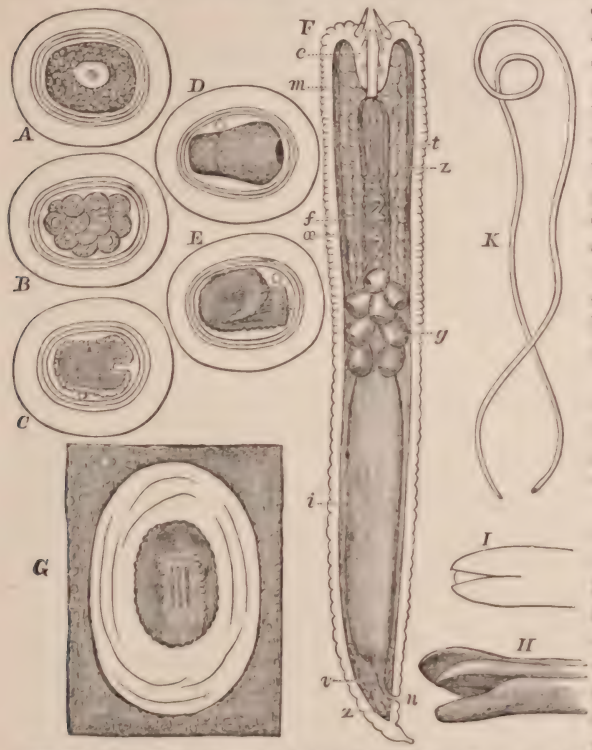

FIG. 66.—GORDIUS AQUATICUS.—A, egg; B, egg undergoing segmentation of the yolk; C, embryo (gastrula) with the primitive stomach an infold of the outer germinal layer of cells (ectoderm); D, embryo farther advanced; E, larva, with the three circles of spines retracted within the œsophagus; F, the same stage greatly enlarged to show the internal organs; *c*, middle circle of spines, the head being retracted; *m*, muscular layer (?); *t*, beak or proboscis; *i*, intestine; *z*, *z*, embryonal cells; *f*, excretory tube leading from *g*, the secretory glands; *œ*, œsophagus; *v*, rectum; *n*, anus; G, the second larva, encysted in a fish—(after Villot). H, *Gordius varius*, end of body of male, much enlarged. I, *Gordius aquaticus*, end of body of male, much enlarged. K, *Gordius aquaticus*, natural size. (H, I, K, drawn by J. S. Kingsley.)

When in this stage, it incessantly protrudes and retracts its armed head, the spines being directed backward when the head is out.

In the first period of larval life the worm lives encysted in the bodies of aquatic fly-larvæ. The vessel in which M. Villot put his *Gordius* eggs also contained the larvæ of *Tanapus*, *Corethra*, and *Chironomus*, small gnat-like flies. He found that each of these larvæ contained numerous cysts with larvæ of *Gordius*. He then removed the larvæ from the cysts, placed them on the gnat-larva, and saw the larval hair-worm work its way into the head of the gnat-larva through the softer part of the integument; during the process the spines on the head, reversing their usual position, enabled the worm to retain its position and penetrate farther in. Then, finding a suitable place, it came to rest and remained immovable. Then the fluids bathing the parts coagulated, and formed a hard, granulated sac. This sac at first closely envelops the body, then it becomes looser and longer, the worm living in the anterior part, the front end of the sac being probably never closed. In this first larval state, the worm is active.

In the second larval period the young hair-worm lives motionless and encysted in the mucous layer of the intestines of small fish, which prey on the gnat-larvæ. A minnow, for example, swallowing one of the aquatic gnat-larvæ, the encysted larva becomes set free by the process of digestion in the stomach of the fish; the cyst dissolving, the young hair-worm itself becomes free in the intestine of its new host. Immediately it begins to bore, aided by the spines around the head, into the mucous membrane lining the inner wall of the intestine of the fish, and then becomes encysted, the worm itself lying motionless in its new home, with its head retracted and the tail rolled in a spiral. The cyst is either spherical or oval. (Fig. 66, G.)

The return to a free state and an aquatic life occurs in the spring, five or six months after the second encystment. It then bores through its cyst and passes into the intestinal cavity of the fish, and from thence is carried out with the fæces into the water. On contact with the water great changes take place. The numerous transverse folds in the body disappear, and it becomes twice as long as before, its head-armature disappears, the body becomes swollen, milky, and pulpy. It remains immovable in the water for a variable period, and then increases in size, the integument grows harder and when about two inches long it turns brown and begins to move.

Thus the development of the hair-worms of the genus *Gordius* would seem to be pretty well made out. Hatching in the water; penetrating the soft larvæ of aquatic flies and there encysting, the young *Gordius* is taken into the stomachs of fishes, becomes freed and again encysts in the mucous layer of the stomach; it finally bores through its cyst and is passed out with the fish's fæces into the water, in which it takes on its final growth.

It is difficult to conceive how these parasites could ever infest insects like locusts, which preferably dwell in dry places, and still more difficult to understand how they could affect katydids, that dwell high up on trees or shrubs,[85] if they are all as essentially aquatic as those studied by M. Villot. It is true that those beetles which frequent moist ground (like the *Carabidæ*) and those spiders which live in the ground are most infested; while it has been observed that the hair-worms are most common during wet weather and more often found in locusts that dwell in low meadows than in those inhabiting higher and drier regions. Still these several insects could not well be affected by a purely aquatic parasite, and the probability is that the hair-worms belonging to this genus are not particular as to their host, and will develop in soft-bodied terrestrial as well as aquatic animals. For it is self-evident that most of those which infest such insects as we have mentioned cannot possibly reach water upon leaving their victims.

Now, either these specimens perish without issue if they fail to reach water, or their young can develop in other soft larvæ dwelling in or upon the earth, and the latter supposition seems the most probable from the circumstances. Yet even on this supposition the mode by which they get into tree-inhabiting insects and such as never descend to the earth, remains as much as ever a mystery, and a further effort of the imagination is necessary to meet the case. We venture the explanation, bold as it may seem, that the excessively minute ova separate and scatter in the water and are sometimes drawn into the air by rising currents or blown into it by winds, either from the surface of pools and ponds, or of the earth; and that permeating the atmosphere, like the spores of fungi and many other minute organisms, they are occasionally brought by rains or heavy dews into contact with those insects and other animals in which they are known to develop. In pools, ponds, or sloughs that dry up in summer, there will be *Gordius* eggs on the surface of the

[85] As in the case of *Mermis acuminata* infesting the Apple-worm.

ground, and if they can bear desiccation without loss of vitality—which is by no means improbable, as some minute animalcules are well known to possess this property—the other conjectures are warranted, for most of the Orthoptera infested by hair-worms are fond of drinking from rain or dew-drops. The life of these minute creatures is devious and precarious, and but an extremely small proportion of those that are born will, under the circumstances we have imagined, be fortunate enough to meet with all the requisitions to successful development; but there is due provision for the perpetuation of the species, through all such vicissitudes, in any animal so enormously fecund as to bring forth nearly seven million eggs.

The hair-worms belonging to the genus *Mermis* have a different anatomical structure, and a quite different life-history from those belonging to the genus *Gordius*. Siebold[86] found *Mermis albicans* plentifully investing the larva of a little white moth with black spots (*Yponomeuta cognatella*, Hübn.), which larva feeds gregariously on *Evonymus europæus*. He also caused them to infest other Lepidopterous larvæ, as of *Pontia*, *Gastropacha*, &c. The *Mermis* acquires full growth within its host, and then forsakes it by boring out with the head. All the specimens so leaving their victim are sexless, and are characterized by a mouth consisting of a very small aperture at anterior end, and by a minute anal point, which is usually curved.[87] Unless they are full grown when the host perishes, or unless they reach moist earth, these asexual worms perish, but if full grown, and they succeed in reaching the surface of moist ground, they at once bore into it, and bury themselves out of sight. Here the sexual organs are developed from a fatty body that the parasitic form contains, and after undergoing one molt the perfect and sexed form is assumed, and the anal end becomes rounded and loses the minute point. During this underground life, no food seems to be required, though several months elapse, and the winter is passed before the animal procreates. The female sexual organs are in the middle of the body, ending externally in a slightly swollen, transverse slit. The male genitals are near the end of the body.[88] The sexes unite in knots, and the female lays her eggs in the ground. The young, which are filiform, like the parent, at once worm themselves to the surface, and enter, as parasites, various soft insects, and mostly those that are found under leaves, moss, &c., near the ground.

From the above brief summary of the life-history of *Mermis*, it is much easier to understand how they come to infest our locusts. Yet even here we are somewhat puzzled to explain the manner in which tree-inhabiting and even fruit-inhabiting larvæ[89] become infested. Siebold

[86] Zeitschrift für Wis. Zool., v, p. 202. Also Ent. Zeitung (Stettin), 1848, p. 292; 1850, p. 329.

[87] An elaborate and admirably illustrated account of the Anatomy and Physiology of *Mermis albicans*, by Dr. Georg Meissner, may be found in Zeit. für Wiss. Zool., v, 1854, p. 207.

[88] As Meissner has shown, there are sexual individuals which in structure seem to approach hermaphroditism, *i. e.*, true females with many of the male external characters.

[89] *Mermis acuminata* (Siebold), as we have seen in the note to page 327, infests the larva of *Carpocapsa pomonella*, which hatches from an egg deposited on the hanging apple, and lives within the apple from the time of its birth till it attains full growth. It has been commonly found infesting the Apple-worm in Europe and of late years in this country. See 5th Mo. Ent. Rep., 1872; Ann. Rep. N. Y. State Mus. Nat. Hist., 1878.

believes that the newly hatched worm (which he wrongly styles embryo) may crawl up the stems and trunks of plants and shrubs by aid of the moisture or extravasation with which these are sometimes covered for hours, and even days, in spring; and this belief seems plausible, and is, in fact, the only way in which, from present knowledge, we can explain the facts. From the studies of this author, and of Diesing, Meissner, and others, it has been concluded that *Mermis albicans* Diesing is but the mature sexual form of *M. acuminata*,[90] which is the asexual form of the species.[91]

Miscellaneous.—In addition to the animals enumerated that feed upon or within the locust after it leaves the egg, there are doubtless many others which occasionally destroy it and that do their small part in helping to keep it in check. Various species of ants have been observed at the work, and Mr. J. I. Salter, of Saint Cloud, Minn., writes, June 7, 1877:

Two or three days since I was told by a man owning land about a mile from me, that the ants in his corn-field were eating the 'hoppers. I repaired with him at once, and found it to be a fact. On entering his field, which is quite sandy, I saw at the foot of the young corn-plants from one to four holes in the ground made by the ants, and the little fellows very busy going down and coming up. I soon learned their tactics. When the young 'hopper got on the young corn, the ants seized him, and four or five ants soon dispatched him. They then dismembered him and carried him down into the ground. The ants are very small, and there are millions of them.

Various spiders, a soldier-bug (*Apiomerus crassipes*, Say), the Carolina Mantis (*Mantis Carolina*, L.), and certain dragon-flies (*Libellulidæ*), have also been observed by our correspondents to occasionally prey upon the Rocky Mountain locust.

CHAPTER XII.

VERTEBRATE ENEMIES.

It is more than probable that the good offices of birds and other vertebrate animals, wild and domesticated, in destroying locusts, notwithstanding all that has been said and written upon the subject, have been underestimated. We are inclined to think that even entomologists, although contending bravely and strenuously for their feathered friends, have not fully appreciated their importance in this work, so far as it refers to the locusts. During the past year the attention of the people in the locust-visited area has been more particularly directed to this question than ever before, and the result as shown by the numerous answers

[90] First described as *Filaria acuminata* by Rudolphi.

[91] *Filaria lacustris* is also but the asexual form of the same. As we have found both the *albicans* and *acuminata* forms truly parasitic (see note to page 327), there would seem to be something still further to ascertain in the interesting life-history of the genus. Siebold gives the following definition of the species:

Mermis albicans: Corpus longissimum antrorsum attenuatum lacteum. Os terminale minimum. Cauda rotundata. Apertura genitalis maris pene cornea duplice munita et ante extremitatem caudalem sita. Apertura genitalis feminæ haud procul post corporis medium collocata. Ovula simplicia alba.

received by the Commission to their questions bearing on this part shows very clearly a waking up to the great importance of securing by proper protection the aid of birds and other locust-eating vertebrates.

The remarkable and apparently mysterious disappearance in the early part of the season of such a large portion of the locusts which were hatched, and also of eggs which had been deposited the season previous (1876), was for a time, and is even yet by many attributed almost wholly to climatic influences and insect and other minute enemies and parasites. While there can be no doubt that these little invertebrate friends have aided very materially in this work of destruction, yet the facts ascertained show very clearly that a large portion is attributable to other causes. Experience has also shown that the destruction by climatic influences is far less than was generally anticipated, especially of the eggs, which were supposed to be comparatively easily affected by the alternations of temperature and humidity. To such an extent has the proof affected public opinion on this point, that it now generally runs to the opposite extreme, and it is quite common to hear those who watched the result during the spring of 1877, say that neither changes in temperature, freezing, cold, heat, or moisture, have any appreciable effect upon the eggs.

But, aside from theory, the ocular demonstration of the usefulness of birds as locust-destroyers was so full and complete during the past year that it was impossible to entertain any longer a doubt on this point. Even those who believed the remedy inadequate to the evil were forced to admit their usefulness in proportion to their numbers. Professor Aughey, who has made this subject a special study for a number of years, remarks in his article on the Birds of Nebraska, which will be found fully quoted elsewhere (App. 2) that "during the summer of 1877 many farmers over the locust-covered region of the West were converted to the policy of protecting the birds by observing their insectivorous habits."

Not only do the extracts from correspondence hereafter given prove positively the great usefulness of birds in this respect, but the members of the Commission while in the field had repeated opportunities of verifying the truth of these statements. In one instance a farmer took one of the members to a field to show him how numerously the young locusts had hatched out, but when he reached the place where they had been so abundant in the morning, to his amazement, none were to be found; the statement by the family that a flock of blackbirds had been in the field during his absence afforded an explanation of the apparent mystery.

In another instance a garden was attacked by an innumerable host of minute locusts; the owner battled bravely with them for a while, but at last, giving up in despair, sat down to watch the progress of destruction of his vegetables and flowers, when suddenly a flock of blackbirds alighted on the young cottonwoods he had planted in his yard. Hav-

ing chirped a song as if to cheer him, they flew into the garden; when they left, an hour or so after, the dreaded "hoppers" were gone and his garden saved.

In some instances gardens and other small areas of vegetables or grain were effectually protected by poultry; at Sioux City, Iowa, an area of some four or five acres planted in vegetables, flowers, and a little patch of wheat, by poultry (hens with young chickens) distributed through it. One of the Commissioners visited it while the locusts were very numerous all around, yet inside scarcely one could be found.

Numerous instances have come to our knowledge of areas of several acres being entirely cleared of eggs by poultry. As will be seen by examining the extracts hereafter given, certain birds also take part in destroying the eggs.

The following extracts are from answers to the question in our circular inquiring as "To what extent have birds, domestic fowls, and other animals, domestic or wild, been useful in destroying these insects?"

DAKOTA.

Sioux Falls, Minnehaha County.—They (birds, &c.) are destroying a great number.

Willowtown, Armstrong County.—All feathered tribes seem to destroy them.

Bon Homme, Bon Homme County.—Domestic fowls have destroyed many; birds have destroyed more than all other animals.

Saybrook, Clay County.—All kinds of birds and fowls.

Walhalla, Pembina County.—Prairie chickens feed on the eggs; their crops on being opened appear to contain nothing but locusts, in their season. Domestic fowls, pigs, and toads feed on them.

Sioux Falls, Minnehaha County.—Birds have destroyed myriads, many fields having been kept clean.

Jamestown, Stutsman County.—In this section, blackbirds.

Sioux Falls, Minnehaha County.—Birds, &c., prove very destructive, but do not seem visibly to affect the numbers. At this season (May) the young, as fast as hatched, are devoured by birds, &c. The birds will usually follow a team all day, going over breakings where the team disturbs the eggs. Blackbirds and wheat-birds appear to pick up the eggs.

Madison, Lake County.—Nearly all domestic and wild birds.

Spring Valley, Turner County.—Blackbirds and domestic fowls.

Wahpeton, Richland County.—Domestic fowls. I have observed my tame crane gathering them in.

MINNESOTA.

Heron Lake, Jackson County.—A great many eggs and young locusts are destroyed by all kinds of birds.

Norwood, Carver County.—Domestic and wild birds do much good; domestic turkey the best.

Worthington, Nobles County.—All wild birds are very useful; the tame ones seem to tire after a few days.

Albert Lea, Freeborn County.—Hens and chickens are of great benefit; will keep a garden entirely free from 'hoppers.

Dewald, Nobles County.—Birds are of great use, especially the blackbird and its varieties. The prairie-hen and most other terrestrial birds do good service.

Excelsior, Hennepin County.—Domestic fowls are very useful.

Magnolia, Rock County.—They destroy an immense number.

Lenhassen, Martin County.—Domestic and wild birds of all kinds have destroyed considerable.

Morristown, Rice County.—Blackbirds, quails, and hens.

Cosmos, Meeker County.—Birds and domestic fowls appear to subsist upon them, but the difference they make is imperceptible.

Mankato, Blue Earth County.—Blackbirds and robins very destructive, but not enough birds in the State.

Detroit, Becker County.—The birds destroy countless numbers. Blackbirds are powerful aids. Domestic fowls sometimes save whole gardens.

Becker, Sherburne County.—Blackbirds best; chickens good; hogs.

Medalia, Watonwan County.—The best friends we have.

Orr, Jackson County.—Destroyed one-tenth.

Banks, Faribault County.—Broods of turkeys and chickens are very destructive. I had a garden of four acres covered with 'hoppers. I hatched about one hundred turkeys and chickens and in a week they had cleaned them out.

Kerkhoven, Swift County.—Chickens, turkeys, and other domestic birds were useful; also, the large yellow-headed blackbird.

Homan, Grant County.—Birds have done good work; blackbirds most.

Moorhead, Clay County.—From the crow down to the little wren they are useful.

NEBRASKA.

Plattsmouth, Cass County.—Domestic fowls in gardens, home-lots, &c., are very useful; birds little use.

Hebron, Thayer County.—All kinds of birds and domestic fowls destroy vast numbers.

Farmers' Valley, Knox County.—Blackbirds, domestic fowls, prairie-chickens, and quails destroy the eggs and young locusts.

Niobrara.—Very useful in destroying young 'hoppers, but do not touch the winged ones.

Ponca, Dixon County.—Very little use; the fowls become disgusted with so many.

Genoa, Platte County.—Blackbirds, cowbirds, and domestic fowls destroy large numbers of eggs and young locusts.

Tecumseh, Johnson County.—Very largely. Blackbirds have been our most valiant friends. All birds, as well as domestic fowls, have aided.

Amazon, Franklin County.—They have destroyed about one-half.

Friend, Saline County.—Prairie-hens, quails, snipes, blackbirds, &c., are useful.

Hooper, Dodge County.—Blackbirds, snow-birds, prairie-chickens, domestic fowls, &c.

Burr Oak, Otoe County.—All domestic fowls and hogs eat them with avidity.

Farmers' Valley, Knox County.—Birds, snakes, frogs, toads eat the insects; birds eat the eggs.

Sunlight, Cass County.—Hogs, prairie-squirrels (gray and striped), chickens, and birds.

Steele City, Jefferson County.—Wolves and skunks eat many 'hoppers.

Arayo, Richardson County.—Hogs and domestic fowls.

Grand Island, Hall County.—Wild and tame pigeons, the eggs and young; domestic fowls, prairie-chickens, grouse, and quails, in any stage of their development; blackbirds feed on the young.

Pleasant Hill, Saline County.—Snakes.

Chapman, Merrick County.—Prairie-chickens, plovers, blackbirds, and larks.

IOWA.

Spirit Lake, Dickinson County.—Birds destroy a great number; grakle, yellow-headed blackbird, barn-yard fowls, wheat-bird, &c.

Lake City, Calhoun County.—Domestic and wild fowls are very efficient in destroying the young. My garden was saved in 1874 by about seventy-five chickens.

Fort Dodge, Webster County.—Birds, squirrels (evidently prairie-squirrels), ground-mice, hogs, and domestic fowls; blackbirds most.

Dakota City, Humboldt County.—Chickens alone have saved gardens here; turkeys the same.

Alta, Buena Vista County.—Birds, domestic fowls, and hogs; hogs will plow the ground for them (eggs).

These reports, taken together, give a very correct idea of the value of birds as locust destroyers, and of the kinds which are most efficient, as will be seen hereafter by what Professor Aughey says, the plovers perhaps do not receive as much credit as they are entitled to The various species of blackbirds, especially the Yellow-headed blackbird (*Xanthocephalus icterocephalus*) appear to have been the most efficient workers. The Prairie-hen or Pinnated grouse (*Cupidonia cupido*) and quail (*Ortyx virginianus*) appear to stand next in order as locust destroyers, and the plovers, especially the Killdeer plover (*Ægialitis vocifera*), the Ring plover (*Æ. semipalmata*), and Mountain plover (*Eudromias montanus*) next, so far as the wild birds are concerned. That domestic fowls are very efficient aids in this work has been proven beyond controversy, and where they have been kept in anything like the number approximating to that which is compatible with the farmer's occupation and interest, they perhaps stand next to the blackbirds in usefulness. It is true as stated by some of the correspondents that after a time they tire and withdraw somewhat from the work of destroying locusts, but if, as Professor Aughey suggests, they are fed for a time on grain they will again return to it with renewed vigor. There can be no doubt that where these are kept in reasonable numbers, with a little care and attention they will keep the gardens and vegetable patches clear of locusts, except in cases of sudden and heavy invasions of winged locusts.

Hogs eat a large number, but are probably more useful in destroying the eggs, of which they are quite fond and for which they soon learn to search. Among the native mammals which destroy more or less of the insects or eggs may be mentioned the skunk, the prairie squirrels, and even the ground mice. Toads also destroy quite a number of the young insects.

As bearing more especially upon the question of the usefulness of birds as locust destroyers, we here insert a paper by Prof. Samuel Aughey, of Lincoln, Nebr., prepared for the Commission. Although we might be disposed to slightly modify it in some respects, yet we agree in the main with the writer in the views expressed, and prefer to let him speak for himself, that the full force of the valuable and important facts mentioned may be felt, and that his earnestness as a bird defender may have its influence upon all who read this report.

SOME FACTS AND CONSIDERATIONS CONCERNING THE BENEFICIAL WORK OF BIRDS.

Even poultry has been found to be invaluable in destroying locusts and other injurious insects. During the summer of 1877 many farmers over the locust-covered region of the West were converted to the policy of protecting our birds by observing their insectivorous habits. Chickens, turkeys, guinea-fowls, geese, and ducks all destroy locusts, especially the three former. Not a few farmers saved a portion of their crops, and especially their gardens, from the locusts, by raising an exceptional number of chickens, and sometimes of turkeys and guinea-fowls, and turning them loose on the infested grounds. A single old hen, with her brood of young chickens, will, for a while, live almost entirely on young locusts if they can be obtained. When tired of them and then fed on some other kind of food for a few days, they will return again

to the locusts with renewed appetites. In this way a great many fruit-gardens have been cleansed of locusts. During the spring of 1877 increased attention was given to this method of disposing of locusts, and though some failures were reported, the great body of those who had given it a fair trial, testify that within certain limits poultry enough can be raised to exterminate the locusts. It is not pretended that entire farms can be saved in this way, but it is claimed that often the gardens and the fields nearest to their roosting-places are ridden of locusts by this simple and also otherwise profitable agency.

It is also probable that the value of chickens and turkeys for the general destruction of insects is underestimated. Those who have carefully examined the stomachs of chickens and turkeys taken at random from a farm-yard have often been surprised at the number of insects that they had confiscated. One turkey that I purchased in a butcher-shop in Lincoln in October, 1874, had 47 locusts and 23 other insects in its stomach One that I dissected in October, 1873, had in its stomach 53 of our common insects. When domesticated they retain the eating habits of their wild state, and take every insect that crosses their path. I have rarely examined the stomachs of chickens without finding some insects. The exceptions to this rule have been generally those that have been kept in confinement. The farmer, therefore, who makes provision for a large amount of poultry on his lands accomplishes a double purpose: his profits are to that extent increased, and a large number of insects that would damage his crops are destroyed.

In the nature of things it is impossible to ascertain absolutely the amount of good that birds do in destroying insects. No one can say with mathematical accuracy what the result would have been if all our birds had been destroyed, or if the number had been double what it is. Only this in general we are sure of, from what has already been stated, that birds destroy an incalculable number of insects, and in so far contribute to the safety of crops of all kinds, as well as the perpetuity of the spontaneous vegetation that clothes the earth. Unfortunately the mass of the people have not and do not observe closely what the birds are doing. Hence they are still the victims of prejudice, and their character is rarely appreciated by the great mass of the people. The following instances of the good work that birds have done no doubt could have been multiplied a thousand fold if there had been a sufficient number of trained and sympathetic observers:

1. In the spring of 1865 the locusts hatched out in countless numbers in Northeastern Nebraska. Very few fields of corn and the cereal grains escaped some damage. Some fields were entirely destroyed, while others were hurt to the amount of from ten to seventy-five per cent. One field of corn northwest of Dakota City was almost literally covered with locusts, and where the indications were that not a stock would escape. After, and about the time the corn was up, the yellow-headed blackbirds in large numbers made this field their feeding-grounds. Visiting the field frequently I could see a gradual diminution of the number of the locusts. Other birds, especially the plovers, helped the yellow-heads. And although some of the corn had to be replanted once, yet it was the birds that made the crop that was raised possible at all.

2. During the same season I visited Pigeon Creek Valley, in this county, and found among the eaten-up wheat-fields one where the damage done was not over five per cent. The Irishman who pointed it out to me ascribed it to the work of the birds, chief among which were the blackbirds and plover, with a few quail and prairie-chickens.

3. In another locality, where the old Omadi road then crossed Omaha Creek, there were a few old abandoned fields where there were enormous numbers of young locusts toward the end of May. I see from my note-book that I estimated that about three hundred locusts hatched out here to the square foot. Some cottonwood and other timber was near by where many species of birds were breeding at that time and later in the season. The birds soon spied out this locust-covered spot and made it their feeding-grounds. I frequently stopped at this place as I passed by, both to find out

what birds existed in the State and to observe their effect on the locust, as I had been then in the West but a short time. But go there when I would, for at least a month more or less birds could be seen on these grounds. Among these were various species of blackbirds, bartramian and other plovers, quails, snipes, curlews, prairie-chickens, and occasionally larks, and in June occasional orioles, sparrows, bobolinks, and robins. Over a thousand birds must have been feeding here. Long before the middle of June arrived most of the locusts had disappeared. And it is remarkable that further down the river, in a settlement called Plyburg, many of the farms enjoyed a special immunity from locust depredations. It appeared to me then that the large amount of low and high, sparse and thick timber in that district so allured the birds that their abundance shielded the people in a large degree from the disastrous effects of these locust visitations. It was a nucleus, a center of dispersion for the timber and lowland loving birds. The fall previous to this Mr. John Smith, who had corn-fields near Plyburg, alone of all the farmers for a great distance around, saved his crops from the locust swarms of 1864.

4. During this same season (the spring of 1865), many of the bluff-lands west of Dakota City, especially where there was new or old breaking, became the feeding-grounds of great numbers of prairie-chickens and plover. There were then very few settlers there, many of them having left because of the locust invasion of the preceding fall. But to me it was remarkable how rapidly the young locusts disappeared where the prairie-chickens and plovers were daily feeding. In such spots by the middle of June hardly a locust was left.

5. At a point about nine miles west of Ponka, on the Niobrara road, the locusts hatched out as elsewhere in prodigious numbers. Here, however, there were some fields that the yellow-headed blackbirds, the quails, and plovers visited in such numbers that few locusts survived to injure the crops. I saw them at work here, and a settler afterward told me that the birds scattered over wider areas after the locust supply began to give out.

6. In August, 1866, the locusts invaded Cedar and Dixon Counties in swarms that darkened the sun. At one point on the Lower Bow, between Saint James and the Missouri, where the ground was covered with them, birds in great numbers in species and individuals made an apparently simultaneous attack on the locusts. Although they did not destroy them all, yet they very perceptibly reduced their numbers for that and the following season. It was amusing to see a large number of swallows glut themselves with locusts on the wing.

7. In June, 1867, I visited these counties (Dixon and Cedar), where the newly-hatched-out locusts were destroying the crops of cereals and corn; and, although I could not remain in any one place more than a day, yet I found several localities where the settlers attributed their immunity from locust losses to the interposition of the birds; and the ones that were credited with most work of this kind were the plovers, various kinds of blackbirds, quail, prairie-chickens, curlews, and snipes. One spot I especially noted. It was near Lime Creek, on the road from New Castle to Saint James. Having camped here on the creek, I found an old abandoned field near by where the locusts were exceedingly thick. On my return I found great numbers of plover and other birds on the ground, and not one locust to ten that had been there when I passed up a week previous. Within a quarter of a mile on these grounds I counted 439 plover, blackbirds, prairie-chickens, and quail. I could come to no other conclusion than that the birds were the cause of the disappearance of the locusts.

8. In June, 1866, the locusts, whose eggs had been laid the fall previous, had been hatched out in countless numbers. One field, in a section a few miles southwest from Decatur, became frequented by an exceptional number of birds. My attention being directed to it, I visited the spot, and found that the locusts had nearly all disappeared. And though I had not seen this spot earlier, yet I had no reason to doubt the statement of the settlers that the locusts had been as thick there as anywhere in the county.

9. In the summer and fall of 1874 the locusts appeared in Southeastern Nebraska in

unusual numbers even for this region. In Lancaster County, where the road to Milford crosses Middle Creek, the blackbirds that were passing southward, so persistently fed on some spots as hardly to leave a locust behind.

10. I happened to be in the Republican Valley, in Southwestern Nebraska, in August, 1874, when the locusts invaded that region. Prairie-chickens and quail, that previous to their coming had a large number of seeds in their stomachs when dissected, seemed now for a time to abandon almost all other kinds of food. At least, from this onward for a month little else than locusts was found in their stomachs. All the birds seemed now to live solely on locusts for a while.

No Nebraskian will forget the countless number of young locusts that hatched out in the spring of 1875. Only where they were removed by causes known or unknown, were crops produced during this season over the infested region. Among the few causes operating in the destruction of locusts during that period was the work of the insectivorous birds. Among the spots that birds frequented was one on the west side of Salt Creek, not more than two miles from Lincoln. There was a small area of about three hundred and twenty acres that harbored an immense number of locusts. The birds, however, made it one of their feeding-grounds, and the locusts lessened daily in numbers. Within a month hardly a locust was left. Similar instances of the work of birds were observed farther down on Salt Creek and on Middle Creek.

In the spring of 1877 the locusts disappeared so rapidly from other causes after they had hatched out, that little opportunity was given to examine what effect the birds had on them. Yet, on Middle Creek and its tributaries, and in various other places, I could see that the birds sensibly and rapidly diminished their numbers. One notable point was a few miles down Salt Creek from Lincoln. In May I visited the spot owing to the reported great numbers of locusts there. I estimated the number when I visited the place to be about one hundred and thirty-five to a square foot. Already the birds had discovered it, and within sight were quail, larks, bob-'o-links, yellow-heads, plovers, curlews, and a few prairie-chickens. They were all apparently feeding on these locusts. With my glass I could see them picking up these insects. In a month hardly a locust was left at this place.

The following letters, giving instances similar to the preceding of the good deeds of birds, have been received in reply to my inquiries:

DEAR SIR: In answer to your inquiries I have only this to say: During the last season I planted a tract of Mr. Brentlinger's land, north of Omaha Creek, in addition to my own, in corn. It was on new breaking, where the locusts had laid their eggs. After planting my corn the locusts began to hatch, and in immense numbers, and threatened to destroy all my corn. The blackbirds, however, in large numbers, commenced to feed on the locusts, and devoured them almost as fast as they hatched out. This gave my corn a chance, and I obtained a good crop, but without the work of the blackbirds this would have been impossible.—[Jacob Heikes, Dakota City, Nebr., October 3, 1877.

MY DEAR SIR: In reply to your inquiry relative to the value of our birds as insect-destroyers, I will mention one instance that came under my personal observation last spring. Adjoining my residence in West Point in this State there was a wheat-field. About the time the wheat was two inches high young grasshoppers made their appearance in great numbers, and in a short time they had eaten the wheat so that the field in many places was as bare as a street. About that time I noticed that large flocks of birds—mostly the common blackbirds—were frequenting this field daily. I soon discovered that they were after the hated 'hopper. I went out frequently to make observations, and I am satisfied that each bird destroyed at least 300 locusts daily. In about ten days the birds ceased their visits, and upon inspection I found that the 'hoppers had disappeared also. The wheat sprang up again, and made a good crop.

There are many other similar instances where birds saved wheat-fields from being destroyed by the grasshoppers in my county, to which my attention has been called by farmers. I observed that orioles (which, by the way, were very numerous with us this season) are great insect-destroyers.—[Senator Crawford, West Point, Nebr., November, 7, 1877.

[Mr. Crawford, the author of the above letter, is a member of the Nebraska State senate, and draughted the present law prohibiting the destruction of our insectivorous birds.]

Yours at hand. * * * There was a patch of new breaking just west of the Methodist church, where the grasshoppers hatched out very early, and where they literally covered the ground. Many of our people went to see these grasshoppers, and among others Mr. Miller, a new-comer. We noticed soon afterwards a flock of blackbirds alight on this piece of ground, and being curious to know whether they were destroying any 'hoppers, we went to see, and found, to our surprise, that the ground was almost entirely cleaned of them.—[Rev. J. F. Kuhlman, Ponca, Dixon County, Nebr., Novembr 2, 1877.

DEAR SIR: I had one field of wheat on which the locusts were at work during the last spring in such numbers that it looked as if nothing would be left. The blackbirds, however, and also the plover, found it out, and came in such numbers that they cleaned out every 'hopper, and I got a good field of wheat.—[Elias Brumer, Grand Island, Hall County, Nebr., September 28, 1877.

DEAR SIR: In answer to your question about the birds and the locusts, I must say this: Every farmer that shoots birds must be a fool. I had wheat this last spring on new breaking. The grasshoppers came out apparently as thick as the wheat itself, and, indeed, much thicker. I gave up that field for lost. Just then great numbers of plover came, and flocks of blackbirds, and some quail, and commenced feeding on this field. They cleaned out the locusts so well that I had at least three-fourths of a crop, and I know that without the birds I would not have had any. I know other farmers whose wheat was saved in the same way.—[S. E. Goodmore, Fremont, Nebr., October 5, 1877.

DEAR SIR: In answer to your inquiry as to what destroyed the most locusts here, I have to say that I don't know as a general thing; but several of my fields, where they were thickest, they were destroyed by birds. The plovers, blackbirds, and a great many other kinds, whose names I did not know, came here and lived, or appeared to, off of my fields. I shot one whose craw was full of locusts. At any rate, the locusts gradually disappeared, and though I do not know positively, I have no doubt that they were eaten by birds. I have no doubt if there were more birds there would be less locusts.—[J. B. Kramer, Blair, Nebr., October 6, 1877.

DEAR SIR: I never noticed the work of birds very much until I read that story of yours, last fall, in the papers, about the remedy against the increase of insects. I thought that it was thin, but don't think so now. This last spring the blackbirds and plovers, and other birds, lit down in such flocks on my grasshoppered fields that they cleaned out at least a part of them—enough for me to get good crops of wheat, barley, and corn. I watched them and could see them eating locusts. I think you are right in wanting all our birds protected.—[John Marlan, Beatrice, Gage County, Nebr.

Yours received and contents noted. People here generally believe that the locusts died a natural death. On my farm, where the birds were thick and fed themselves on locusts, my crops suffered little damage, but where the birds did not feed I got but little. I did not notice the work of the birds until this year, and I was led to do it by your newspaper articles. I am sorry that I know the names of few of the birds that fed on my farm, but there were several kinds of plover and snipe, blackbirds, yellow-heads, quail, and prairie-chickens.—[William Hardle, Delaware, Otoe County, October 9, 1877.

The following examples of birds found with insects in their stomachs and of actual good work done by them, is confirmation, as far as it goes, of the theory that all birds are more or less insectivorous. There are few species, if any, that will not under some circumstances eat insects; and the great body of them prefer insect to any other food. This is true not only of the birds generally considered as insectivorous, but to some extent of the granivorous birds. I have frequently obtained young prairie-chickens that were shot in wheat stubble in August and found to my surprise that there were more insects in their stomachs than wheat and other grains. The only exception to this rule has been in the case of those shot on and around wheat-stacks and straw-piles in winter, in which cases the most of the contents of the stomach were seeds and grains. I had the same experience with quails. All that I captured in wheat-fields after harvest had more or less insects in their stomachs; generally more than half the contents were insects, and the only exceptions were in the case of the few caught around stacks of wheat or straw in winter.

Few unobservant people have any comprehension of the vast number of insects that birds actually destroy. During the breeding season this destruction of insects by birds reaches its culmination. The young of some species will eat about 50, others about 60, some about 55, and some about 75 insects each day. The average cannot be far

from 60. At this rate five young birds would eat about 300 insects each day, or about 9,000 a month for each month, exclusive of the parents. There have been widely different estimates as to the number of insects that old birds eat, but it ought not to be difficult to approximate the quantity. Only a small part of the contents of a bird's stomach is entire enough to be distinguished and counted. If the balance is composed as largely of insects, which is more than probable, then the whole number eaten during a day by an insectivorous bird must be near 200. I reached the same conclusion by actual tests. In the fall of 1874 I bought two Bartramian plovers from some boys who had trapped them, and kept them for a week in a cage before they were set free. I fed them locusts and other insects, which I counted for four days with the following result:

1st day	277
2d day	452
3d day	448
4th day	439
Total	1,616
Average per day	404
Average for each	202

I was compelled to go away or else the experiment would have been continued longer. About one-fourth of the insects were locusts, and the balance were flies, ants, beetles, &c. I gave them whatever insects the boys that I had hired gathered for me. On the first day I failed to get all that they would have eaten, but afterward they had all that they wanted. My impression, however, is that they ate less than they would have done if they had been at liberty. But, lest there might be some mistake, and to avoid all possibility of error on the wrong side, we will base our calculations on an estimate of 150 insects each day for a mature plover. At this rate 20 old plovers would eat 3,000 insects each day, or 90,000 a month. And suppose, further, that these 20 plovers had ten nests, which averaged four young ones each. At 60 insects each day for each young plover, the 40 would consume 2,400 every 24 hours, or 72,000 a month. The 20 plovers and their progeny, together, would consume 162,000 insects each month. At this same rate 1,000 plovers and their young would consume in one month 8,100,000 insects. That many locusts removed in one year from a farm of 160 acres would probably render it capable of producing crops even when these insects are doing their worst. As there are many birds that eat more insects than do the plovers, as well as many that eat less, 150 insects a day is probably a fair average for all insectivorous birds.

Here we meet with still other topics of misapprehension on the part of the general public. It is as to the abundance of insects and their prolific character. Many cannot understand how there can be enough insects to feed birds that devour them at this rate. But it is well known among all naturalists that the lower forms of life are marvelous for the number of species and of individuals and for their fecundity.

When I first came to Nebraska, in December, 1864, there were many species of birds far more abundant than they have been during recent years. I never saw the blackbirds so abundant as they were during 1865 over Eastern Nebraska. As I stated under the head of Bremer's Blackbird, vast numbers of them were poisoned around the cornfields in spring and fall during these years, so that often piles of them could be seen at once that had been gathered together. It was done under the mistaken notion that the blackbirds were damaging the crops, especially the corn. Great numbers of birds of other species were destroyed at the same time. A single grain of corn soaked in strychnine would suffice to kill a bird. For several years previous to my coming this practice had been going on. In a single autumn, in Dakota County alone, not less than 30,000 birds must have been destroyed in this way. Supposing that each of these birds

averaged eating 150 insects each day, we then have the enormous number of 135,000,000 of insects saved in this one county in one month that ought to have been destroyed through the influence of birds. When we reflect, further, that many of these birds were migratory, and that they helped to keep down the increase of insects in distant regions, the harm that their destruction has done is beyond calculation. The killing of such birds is no local loss; it is a national, a continental loss. Besides, this destruction of birds was not confined to one county; it extended to most of the counties in Northeastern Nebraska alone, and to some in Northwestern Iowa at least.

This disturbance of the balance of nature must therefore affect crops sooner or later in the whole Missouri River region, in British America, and in Mexico. And the subject of the protection of insectiverous birds must, or ought, sooner or later, to become not only national, but international. Many of these migratory insectivorous birds breed in British America, and winter along our Southern border or in Mexico. Their destruction, therefore, affects the welfare of three nations; for it can be seen from the data given and the calculations made how important their work must be during the month that they pass through the United States in spring and fall.

In addition to the destructive agency of poison to which I have just adverted, it is better known how man, for purposes of gain, to fill his table and so-called pleasure, has been destroying countless numbers of birds. If a bird could be used to appease hunger, that has been made an excuse for killing it. Prairie-chickens, quail, plover, curlews, and snipe have been especial sufferers from this source. The two former were, a few years ago, trapped, shot, and carried eastward by the car-load. Trapping is now, fortunately, made illegal, but up to the present year it was still lawful to hunt chickens and quail with dogs from July to January. Hunting these birds with dogs was, in my judgment, fully as fatal to them as trapping. It was comparatively easy for a man with a trained dog to shoot from fifty to two hundred chickens in a day in August, before the young were full grown and before they had become suspicious. During the winter of 1877 a law was enacted forbidding the killing of prairie-chickens and quail and most of our insectivorous birds, but unfortunately there is yet no public sentiment sufficient to enforce it everywhere. As the law now stands on the statute-book, it prevents that wholesale capture of birds for shipment that once prevailed. Vast numbers, however, are yet secretly hunted through the instrumentality of dogs and guns. It is no longer done openly, and the birds obtained can no longer be publicly exposed to sale, and the probabilities are that they are now about holding their own. Some of the so-called sporting-men deny that there has been a great destruction of birds by this means. The following, however, are a few of the public notices of hunts that have taken place:

[From Omaha Republican of September 8, 1865.]

On the 6th Captain Hoagland's party bagged 422 prairie-chickens, 4 quails, 6 hawks, 1 duck, 4 snipe, and 1 rabbit; total, 462. Captain Kennedy's party bagged 287 prairie-chickens, 2 quails, 8 hawks, 15 ducks, 6 snipe, and one rabbit; total, 353. Excluding the two rabbits, the total number for one day by these two parties was 813 birds.

[From Omaha Herald of September 10, 1866.]

A. Hoagland, esq., of Omaha, killed in one day 192 prairie-chickens.

In the Herald of September and October, in the years 1867, 1868, and 1869, and down to the present time, there have been notices of the destruction which these hunting or sporting clubs have caused among insectivorous birds.

A few years ago prairie-chickens and quail, as well as snipe, wild geese, and ducks were exposed for sale during half a year in nearly all the butcher-shops of the State. The following note from Bohannon Brothers indicates the quantity sold by them:

DEAR SIR: In answer to your inquiry, let us observe that we did not keep a very accurate account of the prairie-chickens sold by us; but during 1874 and 1875 it must have averaged at least 18 a day for seven months in a year.—[Bohannon Brothers, Lincoln, Nebr., November 2, 1877.

Now, this is one of ten firms in Lincoln engaged in the meat business, and all were, during these days, engaged in selling prairie-chickens, quail, &c., to a greater or less

degree. Probably few sold more, and the greater number of them sold less, than the above firm, but 12 would probably be a fair average for all. This would make 120 prairie-chickens and quail sold per day, or 18,000 for 150 days. Those that were captured by the sporting-men of the town and not taken to the butcher-shops I do not include in this estimate. It is safe to conclude that half this number were captured and consumed in the country; and this would make the whole number from this source 27,000. But even this is not all. In fall and winter vast numbers were formerly shipped to Eastern markets, and are still from some sections of the West. The following statement of S. P. Benadom, who was formerly engaged in shipping prairie-chickens, will give some idea of the enormous numbers that were formerly captured for this purpose:

DEAR SIR: In answer to your inquiry I have only this to say: During the winter of 1875 I was engaged in shipping prairie-chickens, quail, and other game to the Eastern cities, principally Boston and New York. I was only shipping about six weeks, and during that time I sent off 19,000 prairie-chickens and 18,700 quail. About one-half of these were caught in Lancaster County. I cannot tell how many other parties, who were engaged in the same business, shipped. But I am satisfied the destruction of these birds ought to be stopped, because I know that they destroy grasshoppers. The contents of their stomachs show that.—[S. P. Benadom, Lincoln, Nebr., November 5, 1877.

The following I have received from Richardson County:

DEAR SIR: * * * The number of chickens (prairie) shipped from this place in 1874 was 2,400 and of quail 900. In 1875 there were shipped of prairie-chickens 1,800 and of quail 1,200. What the larger towns of the county sent off I do not know; but those shipped are a small part of those killed.—[S. M. Willebert, P. M., Humboldt, Richardson County, Nebr., December 7, 1877.

DEAR SIR: * * * From the best information that I have been able to gather on the subject, there were about 6,000 prairie-chickens and 2,500 quail shipped from this point in the year 1874, and perhaps half as many in 1875. The figures are mere approximations, and I give them as such, as entire accuracy is now impossible.—[Isham Reavis, Falls City, Nebr., November 20, 1877.

The above, from Hon. Isham Reavis, shows the large number shipped from Falls City. The estimates that I have received from Rulo, another large town on the same railroad in this county, are only guesses. One guess made them 6,000 and another 3,000, but taking the last figure we can be sure that there were shipped from the three towns of this county in 1874 not less than 11,400 prairie-chickens and 4,400 quail, besides what were consumed at home.

The following is the estimate from Johnson County, Nebraska, forwarded by Hon. C. A. Holmes, a regent of the State university:

DEAR SIR: I have made some inquiry concerning the number of prairie-chickens shipped out of our county. There were shipped from Tecumseh by one firm 6,500 prairie-chickens during the winter of 1874–'75, and about 3,500 from Sterling during the same time. Total, 10,000 from our county. During the same time some quail were shipped, but not such large numbers, probably about 6,000. But this is an estimate. The number of chickens is ascertained from parties who know.

I knew a great many chickens were shipped, but had no idea that so many were sent away. In addition to the number shipped you can easily say that at least 2,000 more were consumed in the county, as people generally lived on game that winter.—[C. A. Holmes, Tecumseh, Nebr., November 10, 1877.

SIR: In answer to yours of September 30, let me say that I find it impossible to ascertain the number of prairie-chickens shipped from this county in 1874. When I was in town last week I made some inquiries, and the estimates ranged from 4,000 to 10,000 and about half that number of quail. For 1875 there were nearly as many. But, judging from the number that I knew were caught, there must have been not less than 20,000 prairie-chickens destroyed in 1874 in this county alone.—[James E. Bolden, Pawnee City, Nebr., November 1, 1877.

There were vast numbers of prairie-chickens also shipped from Cass and Sarpy Counties in these years, but I have not been able, after the most diligent efforts, to obtain estimates that can be depended on. For Cass they vary from 6,000 to 15,000, and for Sarpy from 5,000 to 11,000. The same can be said of Douglas, Washington, and Burt Counties.

One estimate of the number shipped from Dakota County for the year 1874 made the number 7,000, and another 10,000; but wherever I have prosecuted my inquiries in 30 counties of the State the testimony was unanimous that the number of prairie-chickens and quail that were trapped and shipped was simply enormous. And for these 30 counties the average for each county, counting in those that were consumed at home, must have been at least 10,000 prairie-chickens and 5,000 quail. This is a very low estimate, but it is best in these calculations to under rather than to over estimate numbers.

Now, it is well to look at the enormous number of insects that these two species of birds might have destroyed had they been permitted to live.

Number destroyed in each of thirty counties.

	Prairie-chickens.	Quail.
	10,000	5,000
	30	30
Destroyed in 30 counties	300,000	150,000
	150	150
Insects destroyed in one day, at 150 insects to each chicken and quail	45,000,000	22,500,000
	30	30
Insects destroyed in one month	1,350,000,000	675,000,000
	6	6
Insects destroyed in six months	8,100,000,000	4,050,000,000
	4,050,000,000	
Total number of insects destroyed in six months	12,150,000,000	

It should be observed here that the counties embraced in the above calculation cover only the eastern one-third of the State; and I submit whether, if this calculation were extended into the remainder of the State, Kansas, Missouri, and Iowa, it would not account for a large portion of the insect-ravages that interfered with the prosperity of those regions. This calculation should be compared with that made on a previous page concerning the good work of other insectivorous birds, in order to understand the damage done by destroying the natural enemies of insects.

Many of the devotees of bird shooting maintain that such an increase of birds as is contemplated in order to so limit the development of insect-life as to preserve all forms of vegetation from their ravages, would in the end be destructive to our crops. There would not, they claim, be sufficient insects to feed them, and in their absence they would necessarily attack our grain and corn fields. In reference to this it may be observed that it is doubtful whether there are any well anthenticated cases where birds have to any extent been injurious to wheat or corn fields, with the exception of the crows. The blackbirds that were condemned for opening ears of corn were really after the grubs that were destroying it. The prairie-chickens and quails that are captured in wheat-stubbles and corn-fields are found to have more insects than grains in their stomachs. The only exception to this rule that has come under my observation has been where sometimes prairie-chickens and quail have been shot on wheat and straw stacks, and in corn-fields in winter. But the grain that is lost in straw at threshing-time would be lost at any rate, and the quantity that can be stolen from the outside of a stack in winter is small at best; and the number of farmers who postpone husking their corn till winter or spring is becoming smaller each year. The greater part of the thrashing throughout the west is also now done in the fall. Generally our granivorous birds only take what is left after the agriculturists have gathered what they could. What the birds take would have been lost at any rate.

There is still another beneficent work that these birds that are partly granivorous in winter accomplish for agriculture, a work for which they have never received

credit, and which from its very nature it is impossible accurately to estimate. *They destroy countless numbers of noxious seeds.* The difficulty of keeping cultivated lands clean of weeds is proverbial, and the difficulty, it is claimed, is becoming greater each year. Cannot this difficulty be traced to the same cause, in part, as the increase of insects injurious to vegetation? Let any one examine the stomachs of quails and prairie-chickens in winter and note the character of the seeds that constitute their food, and it will be found that a large per cent. are composed of kinds that are injurious to agriculture. The following I have particularly noted:

LINCOLN, NEBR., February, 1874.—Four prairie-chickens were examined. The contents of the first were 1 grain of corn, 5 grains of wheat, 38 seeds of polygonums (mostly *P. amphibium*), 7 seeds of cassia, and 13 of sun-flowers, and 17 that I failed to identify. The contents of the second were 14 seeds of polygonums, 31 sun-flowers, 3 cassia, 11 verbenas (wild), 4 euphorbias, and 13 wild-rose seeds. The contents of the third were 13 seeds of the cassia, 29 of wild roses, 12 seeds of polygonums, 2 grains of wheat, 1 grain of barley, and 34 that I could not identify. The fourth chicken had in its stomach 15 seeds of the gentians, 33 of rag-weeds, 3 of wild roses, 4 of euphorbias, and 29 minute seeds that I could not identify. Of the eight quail that I examined during the same month, only one had a few grains of wheat in its stomach. All the rest were filled with grass-seed and the seeds of weeds, principally the latter. Those that I examined in the winter of 1875 gave the same average results.

Now, in view of these facts, which could be multiplied to any extent, the assertion that a great increase of our insectivorous birds would be damaging to any products of the land cannot be sustained. But even supposing that some damage was done to crops of cereals, corn, fruits, and the gardens by the occasionally grain and fruit eating birds, would it not be better to suffer a little loss from them than the destruction of whole crops from insects? A. S. Packard, jr., estimates that the loss from locusts in a single year in the Western States amounted to $45,000,000, and from all kinds of insects $200,000,000. Now, if birds could be produced in sufficient numbers to save one-half of this loss or $100,000,000 a year, would it not be better to share one-fourth of this sum with the birds if this were necessary. But it is doubtful whether the birds would need even this comparative small amount to be expended on them. All the facts at our command indicate that the proposed increase would demand the sacrifice of a very small fraction of the products of the land. Only when the birds do a tithe of the damage that is now being done by insects, and not till then, should permission be given for their destruction.

But even if there were considerations which would justify the killing of partially grain-eating birds (which I do not admit), there are none whatever that can sanction the destruction of those that are wholly insectivorous. Nearly all, for example, that belong to the woodpecker, plover, and snipe families are wholly insectivorous, as well as many that belong to other orders.

I do not mean to say that every bird without exception should be so protected as to cause its indefinite increase. There may be an occasional exception, but such exceptions must be rare indeed. Ex-Governor Robert Furnas, of Brownville, Nebr., reports that the Baltimore oriole is exceedingly damaging to the finest grapes; that it plunges its bill into them and thus causes their decay without even eating any, or at least very few. I have not observed this habit myself, but, as he is a close observer and a friend of the birds, he cannot well be mistaken. I hope his experience is exceptional, but, if not, we probably must leave this beautiful bird outside of the protection of the laws.

Unfortunately man often thoughtlessly destroys numberless birds. Sometimes in May and June, and even earlier, when grouse, quail, plover, and other birds are nesting, the prairies are burnt off, so as to produce tender grass for cattle later in the season, or for other unknown reasons. In June, 1869, I passed over a small portion of Wayne County behind a raging prairie-fire. In one hour I found ruined nests of 13 prairie-chickens, 9 quail, 5 plover, and 3 other nests that I did not recognize. In some seasons many thousands of nests are destroyed in this way. No prairie should be

burnt off in Nebraska later than the middle of April, or at least the 1st of May, or else some birds are sure to lose their nests or young. Stringent legislation should be invoked to stop such vandalism. The great majority, however, who indulge in such practices will voluntarily abstain from them without the aid of restraining laws whenever they understand the harm that it does.

Like the human race, birds often suffer a great deal from the conduct of their own kind. Among the birds most hostile to birds are the blue jays. They rob the nests of other birds of their eggs. Wantonly they often kill even the young and throw them out of the nest. The increase of jays is, therefore, incompatible with the general increase of insectivorous and other small birds, especially of those that nest on trees and shrubs. It is hard for the naturalist to give up such a dandy among birds, but, as he is only a blackleg in fine clothes, the feathered tribes are healthier and safer without his society.

Perhaps no bird causes such wholesale destruction among birds as the cowbird. Its habit of laying its eggs in the nests of other birds, one only in a nest, and leaving them to be hatched out and nourished by the foster parents to the destruction of their own kind merits banishment and death. Unfortunately they are abundant in Nebraska, but as attention is being directed to their bad habits a limit will soon be made to their increase. Even crows and magpies do much less harm to other birds than jays and cowbirds.

DAMAGE DONE TO INSECTIVOROUS BIRDS BY BIRDS OF PREY.

As will be seen in the part of this paper devoted to an examination of the food of birds, many of the order *Raptores*, or birds of prey, feed more on insects, reptiles, and the small mammalia, especially mice, gophers, and ground-squirrels, than they do on birds. Some indeed never or rarely feed on birds. It is, therefore, a great mistake to destroy such. The following, however, feed principally on birds, and it will be best to shoot them. I mention only those that are common to Nebraska, but what are found here will probably all be found in Iowa and Kansas.

Those that will carefully examine the stomachs of owls will see that the greater part of them live principally on insects. In Nebraska the white owl (*Nyctea scandiaca*) destroys small and large birds, and should be banished, but the remainder generally are not chargeable with this fault. But the following members of the hawk family are more or less destructive to birds: Cooper's hawk (*Accipiter cooperi*), American goshawk (*Astur atricapillus*), prairie falcon (*Falco polyagrus*), duck-hawk (*F. communis*), American merlin (*F. richardsoni*), sparrow-hawk (*F. sparverius*). This last will be seen to destroy an equal quantity, in bulk, of insects, small mammalia, and birds. The same can be said of the hen-hawk (*Buteo borealis*). Swainson's buzzard (*Buteo swainsoni*) is in many sections looked on as an especial foe to birds; but it is doubtful whether it eats anything besides insects, the smaller mammalia, and reptiles. The cases when it captures a bird must be rare. The American rough-legged hawk (*Archibuteo lagopus, var. sancti-johannis*) also live mostly on other than bird-food, although regarded by many as specially obnoxious. For the sake of having as great a variety as possible of insectivorous birds, if for no other reason, it is certainly desirable to preserve all the birds of prey that are not injurious to the feathered tribes. For this purpose it is important for people to learn to distinguish between the useful and the injurious Raptores.

It has been suggested that the general economy of nature in the fertilization of plants would be interfered with by a general destruction of insects. But in Nebraska, at least, there are no plants of economic importance that would suffer from such a result. Even the few species of orchids in this Territory would continue to attract insects enough to perpetuate their kind. I have observed the Buffalo berry (*Sheperdia argophylla*) to be fertilized by insects. But where this shrub is cultivated the staminate and pistillate individuals can be placed close enough to be fertilized by the winds. Red clover is not yet grown to any extent, and it is doubtful whether this plant is as dependent on insect agency for its fertilization as some authors have maintained.

THE ENGLISH SPARROW.

Some persons have advocated the introduction of the English sparrow in order to mitigate our insect plagues. Such a policy, it appears to me, would be highly objectionable. The moral qualities, or what is near akin to moral qualities, of the English sparrow are bad. Where I have seen this bird in America it has gradually driven off our small native birds. Around Philadelphia, where it has now monopolized the ground, I last year renewed its acquaintance. I again revisited some of my old haunts where in early life I studied our native birds. I could hardly find a blue bird, a robin, or native sparrow where they were abundant in 1858, 1859, 1860, and 1861. The English sparrow, however, greeted me everywhere. It was the opinion of all that I consulted that it had driven off the native birds. Certainly this, to say the least, is unfortunate. Many kinds of birds not only give more variety, but they certainly destroy insects of more species than a single one. If we protect our own native birds, and especially if we cultivate groves of timber where they can find shelter, and banish hunting-dogs, guns, and traps, in a comparatively few years the balance of nature must be so restored that insects will rapidly decrease and again reach the normal number that prevailed at the first settlement of the country. Besides, it is well known that the English sparrow has become partially naturalized in a small section of Nebraska. Some years ago, as I have learned from Hon. J. Sterling Morton, the English sparrows were introduced into Nebraska City, and have multiplied to a considerable extent, but the number of species of insects that they feed on, as has been anticipated, has been found to be small. This of course could have been endured if they were not so hostile to other birds, native to the soil, that do much better.

Another fact concerning these sparrows, not well known, is that they are only partly insectivorous; they are more granivorous than insectivorous, and in their native habitats they are often destroyed because of their destructive raids on wheat and other grain seeds. They have, therefore, far less claim on our protection and care than our own far more beautiful and more highly insectivorous birds. It is another illustration of the fact that sometimes we go abroad for that which we have in greater perfection at home.

The logic of this paper is not affected if the assertion is true that civilization naturally causes an increase of insect life, even though the number of birds should not be diminished. If this were true, then it could be still legitimately claimed that to offset this increase of insect life increased protection should be given to our birds. Our birds should be made to increase in proportion to the increase of insect life which civilization produces, if this theory is correct. And the argument for the necessity of increasing the number of birds is strengthened by the alleged fact, if fact it be, that the progress of civilization destroys great numbers of the lower and smaller mammalia, such as moles and skunks, that largely or entirely feed on insects. These ought not and cannot, for other reasons, be voluntarily perpetuated. Birds, however, can be substituted for them with advantage to the beauty, if not to the harmony, of nature. Here, as elsewhere, the slightest apparent causes often change the ordinary economy of nature, and man, who is such an efficient agent of change, must sooner or later use his mental superiority in planning remedies for the ills which his thoughtlessness or criminality has produced.

WHAT PUBLIC SENTIMENT NEEDS.

Public sentiment is still in need of being corrected on the subject of man's duty to brute, and especially to bird, life. Unfortunately, a certain portion of the people still justify making birds a mark for trials of skill in the use of fire-arms. At certain seasons of the year a portion of the secular journals contain notices of shooting-matches, where thousands of pigeons are butchered to see who can hit oftenest at short range with a shot-gun. Pigeons are bought for this purpose, and after being brought to the so-called sporting-grounds and kept cooped until the shooter is ready, the poor bird is let go to be riddled with shot, if the marksman is sober and skillful

enough to hit it. The man who shoots the most on the wing within a certain distance is declared the victor in this noble amusement! No language can express the brutalizing influence of such exhibitions. They tend to harden and deaden the keenest sensibilities, and the men who pass through such experiences, and those who witness them, without moral deterioration, must possess more than ordinary original endowments of character. They too often train the young who witness such sports to look on acts of barbarity without a qualm, and the men who indulge in such practices can rarely exercise conscientious scruples against the killing of any kind of birds. In fact, they see no harm in it, and are amazed that any one else should. The faculty to feel and to see such wrongs, if it ever existed, is, by such practices, slowly but surely eliminated. And when such shooting-matches occur, as they often do, at our county and State fairs, they are supposed to have legal and moral sanction, or at least justification of some sort, and are of course more wide-spread in their influence for evil. When I asked some boys who were watching the pigeon-shooting at the last State fair at Lincoln, Nebr., what they thought of it, they replied that they did not know before that it was wrong to shoot birds. It is true that generally the moral sense of the public revolts at such exhibitions, and that they are tolerated because of the mistaken notion that the managers of fairs must pander to all kinds of tastes in order to make such shows profitable. But the very tolerance of such brutal exhibitions is evidence of a lack of the highest moral standards, or else they would be no more endured than open gambling or stealing. The time has certainly come for the higher civilization to eliminate this vestige of barbarism from our institutions. It is always best to do right, and to do right here would be a great step toward securing universal love and protection for our wild birds.

It is remarkable that in this last quarter of the nineteenth century there should be such large numbers in the most enlightened countries in whom the savage spirit survives. For shooting wild birds, often maiming and crippling them, inflicting on them the acutest torture, is no less cruel and brutal than the cock-fighting of Spain and the bull and other animal contests of imperial Rome. In many respects it is much more cruel. Birds have a very highly organized nervous system, and must be keenly susceptible to pain. Almost everything that they do indicates this. Their quick movements, their marvelous aërial evolutions, their attachments, their maternal instincts, their evident enjoyment of the beautiful, and the wonderful powers of song that many possess, all attest their high physical organization and prove the greatness of the cruelty that would ruthlessly deprive them of life. The surprise is greater when we reflect that some men of education, and in other respects of high character, indulge in the so-called sport of shooting innocent birds. It may be sport, but is it not the sport of a barbarian and the enjoyment of a savage? No doubt future ages will look on the wanton killing of birds in this period with the same surprise and disgust that we feel in reading the stories of the animal contests in the Roman arena.

CHAPTER XIII.

REMEDIES, AND DEVICES FOR DESTRUCTION.

In this chapter we shall treat of the available means to be employed either for the destruction of the Rocky Mountain locust in one state or another, or for preventing its injuries. The instructions of the former character will apply more especially to what we have termed the Temporary region, or that more fertile country subject to occasional visitation, but in which the insect is not indigenous; the suggestions of the latter to what we have called the Permanent region.

During the summer of 1877, we received a number of plans and suggestions for the destruction of the locust; some of them direct, others through the Department of the Interior. Many of these were sent by persons having no experience whatever with the insect, and were purely theoretical or visionary; while others were intended to gratuitously advertise some pet patent nostrum. We have taken notice of those only which gave some promise of possible usefulness. Of the machines and devices for destruction submitted to us, we have endeavored, as far as time would permit, to personally examine and test in the field all such as appeared worthy of trial; and, where personal attention could not be given, to have such test made by competent parties. We shall illustrate or describe all which came under our notice that are in any way worthy of consideration.

The means to be employed for the destruction of this pest very naturally fall into five divisions: 1, encouragement of natural agencies; 2, destruction of the eggs; 3, destruction of the young or unfledged insects; 4, destruction of the mature or winged insects; 5, preventive measures.

ENCOURAGEMENT OF NATURAL AGENCIES.

While little practically can be done by man to further the multiplication of the more minute enemies of the locust enumerated in Chapter XI, much may be done to protect, and to promote the multiplication of, the larger animals treated of in Chapter XII—especially the birds. These should be protected by most stringent laws, firmly carried out, restraining the wanton destruction too often indulged in by sportsmen and others. Some of the States interested in this question have of late years passed good laws for the protection of these feathered friends, but the laws are, unfortunately, too often a dead letter for want of enforcement. One of the most effectual and successful ways of protecting and encouraging many of the smaller birds is to offer a reward for hawks. This has been done with very beneficial results in Colorado, and other States would do well to follow her example.

DESTRUCTION OF THE EGGS.

The destruction of the eggs has been followed, in the older countries of the East, since Pliny's time, and has long been recognized in Europe and Asia as one of the most efficacious means of averting locust injury. These eggs are laid in masses, just beneath the surface of the ground, seldom to a depth of more than an inch; and we have already considered the character of soil and the sites preferred by the females in laying them. In years like 1874 and 1876 we have known favorable locations, for many hundreds of square miles, so thickly supplied with these eggs that scarcely an inch of the soil could be stirred without exposing them. As a rule, the dead bodies of the locusts strewn about the ground in autumn are a good indication of the presence of eggs in such ground, though the eggs may often be abundant without this indi-

cation. The means to be employed in destroying locust-eggs may be considered under the following divisions: 1. Harrowing; 2. Plowing or spading; 3. Irrigation; 4. Tramping; 5. Collecting.

"There are many questions respecting the manner in which the eggs of this locust are affected under different conditions, which are of intense practical interest, and which are frequently discussed with no definite result being arrived at, and no positive conclusion drawn. Such are, for instance, the influence of temperature, moisture, and dryness upon them; the effects of exposing them to the air, of breaking open the pods, of harrowing or plowing them under at different depths, of tramping upon them. Everything, in short, that may tend to destroy them, or prevent the young locusts hatching, is of vital importance."

With a view of settling some of these questions, and in the hope of reaching conclusions that might prove valuable, Mr. Riley carried on, at Saint Louis, during the winter of 1876–'77, a series of experiments, some of which we shall report, in their proper connection, as they were originally recorded.

By reference to the following meteorological table, the exact temperature at any of the dates mentioned may be ascertained:

Temperature at Saint Louis, Mo., of winter of 1876–'77.

1876.	Max.	Min.	Mean.	1876.	Max.	Min.	Mean.
November 15	41	30	37	December 29	19	10	14
16	44	35	39	30	21	4	15
17	47	40	44	31	34	17	24
18	47	25	34	1877.			
19	36	22	32				
20	45	31	38	January 1	24	13	14
21	47	32	37	2	21	8	15
22	42	23	35	3	26	11	21
23	45	31	36	4	42	19	33
24	51	32	41	5	42	29	36
25	47	31	40	6	43	32	37
26	38	30	34	7	35	13	21
27	45	31	39	8	13	—4	7
28	39	23	28	9	28	1	19
29	33	27	29	10	35	21	31
30	27	15	16	11	52	32	40
December 1	20	4	14	12	32	14	19
2	24	5	16	13	27	10	22
3	29	12	23	14	34	22	31
4	34	24	30	15	43	23	33
5	45	24	34	16	23	9	18
6	47	33	38	17	40	20	35
7	47	31	39	18	46	35	42
8	40	3	15	19	50	39	45
9	11	—5	5	20	46	21	22
10	37	9	31	21	37	19	32
11	55	28	44	22	37	23	26
12	60	36	48	23	32	10	24
13	50	38	42	24	31	19	26
14	38	18	27	25	48	22	36
15	45	12	36	26	51	32	39
16	44	4	12	27	50	31	41
17	27	13	20	28	57	33	47
18	22	2	16	29	57	38	49
19	37	18	28	30	65	48	57
20	43	23	33	31	66	53	59
21	43	23	34	February 1	69	50	59
22	37	20	26	2	56	44	49
23	24	13	19	3	48	35	37
24	19	11	15	4	46	32	39
25	21	13	18	5	40	28	33
26	21	13	18	6	49	34	41
27	24	15	21	7	53	38	46
28	26	17	21	8	47	36	42

Temperature at Saint Louis, Mo., of winter of 1876–'77—Continued.

1877.	Max.	Min.	Mean.	1877.	Max.	Min.	Mean.
February 9	50	33	44	February 24	35	29	32
10	58	37	48	25	33	28	31
11	58	42	52	26	43	28	37
12	52	29	32	27	48	28	40
13	36	28	33	28	50	32	43
14	44	30	38	March 1	47	39	43
15	53	31	44	2	47	37	39
16	47	38	40	3	49	18	29
17	50	34	42	4	32	14	26
18	66	34	53	5	40	26	34
19	58	34	37	6	55	30	46
20	48	27	39	7	57	36	47
21	65	34	51	8	55	18	23
22	53	44	47	9	23	9	18
23	44	33	38	10	41	16	31

1. HARROWING IN THE AUTUMN.—To appreciate fully the effect on the eggs of harrowing in the autumn, it is necessary to understand in what manner they are affected by freezing and thawing, as well as by exposure.

Experiments to test the effects of alternately freezing and thawing.—The eggs in the following series of experiments were obtained early in November, at Manhattan, Kans., under similar conditions. They were mostly in a fluid state at the time, and none but good and perfect masses were used. They were all carefully placed in the normal position at the surface of the ground, in boxes that could be easily removed from place to place. The experiments commenced November 10, 1876, and ended in April, 1877. During November and December the weather was severe, while during January and February it was largely mild and genial for the season. In March again there was much frost.

The temperature in the office, into which all the eggs when not exposed were brought, ranged during the day from 65° to 70° F., rarely reaching to 75°. During the night it never dropped below 40°, and averaged about 55°.

Experiment 1.—Fifty egg-masses were exposed to frost from November 10 to January 10, and then taken in-doors. In twenty days they commenced hatching, and continued to do so for thirty-eight days thereafter.

Experiment 2.—Fifty egg-masses exposed at the same time to frost. Brought in-doors on December 10. On December 31 they commenced hatching numerously, and continued to hatch till the 10th of January, 1877, when the remainder were exposed again. The weather being subsequently mild, some hatched on each warm day until the 26 h. None hatched thereafter, and upon examination, subsequently, all were found to have hatched.

Experiment 3.—Fifty egg-masses exposed at same time. Brought in-doors December 1. Kept there till the 22d without any of them hatching. Exposed again for three weeks, and then brought in-doors on the 12th of January. They commenced hatching two days thereafter, and continued till the 29th. Subsequent examination showed them all to have hatched.

Experiment 4.—One hundred egg-pods exposed at the same time, but alternately brought in-doors and exposed again every fourteen days. Some commenced hatching during the second term in-doors; others continued during the warm days of the third exposure, and all had hatched by the sixth day of the third term in-doors.

Experiment 5.—A lot of one hundred egg-masses alternately exposed and brought in-doors every week. During the first four terms of exposure they were continuously frozen, while during the next four the weather was frequently mild enough to permit hatching. They first began to hatch during the fourth term in-doors, and continued to hatch, except during the colder days when exposed, until the seventh term in-doors, during which the last ones escaped.

Experiment 6.—Many hundred egg-masses kept outdoors the whole time, first commenced hatching March 2d, and continued for thirty-eight days thereafter.

Experiment 7.—Many hundred pods kept indoors till December 15, and hatching from November 28 up to that time, were then exposed, and continued to hatch whenever the weather permitted, up to April 10.

Experiment 8.—A lot of one hundred pods that had been hatching in-doors from November 19, were exposed to frost January 15, and brought in-doors again January 28, where they continued hatching till February 10. Every one was subsequently found to have hatched.

Experiment 9.—A lot of one hundred under same conditions as in Experiment 8, up to January 28. They were then exposed again and brought in-doors February 16, when they commenced hatching and continued to do so till the 27th. All were found subsequently to have hatched.

Two important conclusions are deducible from the above experiments. First: The eggs are far less susceptible to alternate freezing and thawing than most of us, from analogy, have been inclined to believe. Those who have paid attention to the subject know full well that the large proportion of insects that hibernate on or in the ground are more injuriously affected by a mild, alternately freezing and thawing winter than by a steadily cold and severe one, and the idea has quite generally prevailed that it was the same with regard to our locust-eggs. But, if so, then it is more owing to the mechanical action which, by alternate expansion and contraction of the soil, heaves the pods and exposes them, than to the effects of the varying temperatures. Second: That suspended development by frost may continue with impunity for varying periods after the embryon is fully formed and the young insect is on the verge of hatching. Many persons, having in mind the well-known fact that birds' eggs become addled if incubation ceases before completion, when once commenced, would, from analogy, come to the same conclusion with regard to the locust-eggs. But analogy here is an unsafe guide. The eggs of insects hibernate in all stages of embryonic development, and many of them with the larvæ fully formed and complete within. The advanced development of the locust embryo, frequently noticed in the fall, argues nothing but very early hatching as soon as spring opens. Their vitality is unimpaired by frost.

Experiments to test the effects of exposure to the free air.—The eggs in the following series were obtained at Manhattan, Kans., in November, and all under similar conditions:

Experiment 26.—A large number of egg-masses were thoroughly broken up and the single eggs scattered over the surface of the ground outdoors early in December. By the 23d of February all had perished, and most of them had collapsed and shriveled.

Experiment 27.—A large number of pods were partly broken up and exposed, as in Experiment 26. On the 10th of March the outer eggs were mostly dead and shrunken, but a few of the protected ones were yet plump, the embryon well advanced and apparently sound. Placed in earth they subsequently hatched.

Experiment 28.—A large number of unbroken pods were exposed under similar conditions as in the preceding experiments. By March 10 fully three-fourths of the eggs had perished, and by April 1 all had perished.

Experiment 29.—Fifty egg-masses were kept indoors in an open-mouthed bottle in perfectly loose and dry earth from November 6. Fully eight per cent. of the eggs had hatched by December 28, when hatching ceased, and a subsequent examination showed the rest to have shrunken and perished.

It is very evident from the above experiments that we can do much more to destroy the eggs by bringing into requisition the universally

utilizable air than we can by the use of water, which will be presently considered. The breaking up of the mass and exposure of the individual eggs to the desiccating effects of the atmosphere effectually destroys them, and when to this is added the well-known fact that, thus exposed, they are more liable to destruction by their numerous enemies, we see at once the importance of this mode of coping with the evil.

Harrowing in the autumn, then, or during dry, mild weather in early winter, will prove one of the most effectual modes of destroying the eggs and preventing future injury, wherever it is available. It should be enforced by law, as we shall presently suggest in considering legislative action, whenever the soil in any region is known to be abundantly stocked with eggs. A revolving harrow or a cultivator will do excellent service in this way, not only in the field, but along roadways and other bare and uncultivated places. The object should be, not to stir deeply but to scarify and pulverize as much as possible the soil to about the depth of an inch. Where the cultivator is used, it would be well to pass over the ground again with a drag or a brush harrow for this purpose. Some of our correspondents have urged, and with some reason, that wherever land can conveniently be prepared to induce the females to oviposit in it, as by plowing and then rolling when the insects are beginning to breed, such preparations should be made. A subsequent harrowing will be the more easy. In practice, this method will not often be adopted, because it will pay only under exceptional circumstances.

We give here a few of the views of correspondents on the subject of harrowing expressed during the past year:

Harrowing has been tried with success, especially when fowls, swine, &c., have been given access to the ground. In one case, a piece of two acres was entirely freed from the eggs in this way.—[Robt. Milliken, Emporia, Kans., September 15, 1877.

Harrowing the ground in the fall is always beneficial; it brings many of the eggs to the surface, where they are picked up by birds and fowls and otherwise destroyed.—[E. Snyder, Atchison, Kans., June 26, 1877.

The reports of the results of this latter method of destruction are conflicting, varying according to the care expended upon the work, the lateness of the season at which it was done, and the accuracy with which the results were noticed.

In cases where new breaking thickly filled with eggs was passed over once or twice with a seeder in November or late in October, a portion of the eggs were left undestroyed, and these, hatching in the spring, the young devoured the grain as fast as it grew. In other cases eggs brought to the surface late in the fall retained their vitality (the young were fully formed in the eggs) during the winter; but afterward, when they had been fully exposed in February and March to alternate heat and cold, without a covering of snow, only a small fraction of them could be hatched. In other cases, where the number of eggs was not excessive, the proportion of eggs left undestroyed after fall harrowing was too small to cause (of themselves) any serious damage in the spring. From all the inquiries that I have been able to make during the season, I am confirmed in the statement made last year, that it is desirable to bring the eggs to the surface at the earliest possible moment after there is any assurance that the laying season is over; in other words, they should be exposed to the sun while their contents are still fluid.—[Mr. Allen Whitman, special assistant.

Some eggs were harrowed up during mild weather in winter and greedily devoured by tame fowls. Some egg-masses that were exposed in February mostly hatched.—[G. B. Brown, Guilford, Kans.

Harrowing the ground in the fall is good; every egg-mass that is broken or brought to the top is used up. Last fall was an unusually wet one, and great numbers of eggs

were unearthed by the rains, and I will venture to say that of the egg-masses that were so washed out not one ever has or will hatch. Uncovering the egg-masses in the fall is fatal to them all.—[A. H. Gleason, Little Sioux, Iowa, May 21, 1877.

We want to get the young to hatch as soon as possible in the spring, and then go at them with the "'hopper dozer" determinedly and unitedly, and we can destroy them. To that end I believe harrowing is to be recommended for several reasons; first, many of the eggs are spoiled by the sun and weather; secondly, the birds can get at them better and devour millions of them; and, thirdly, those that are not destroyed hatch early and can be killed before the vegetation gets too rank, as afterward it is far more difficult to capture them.—[J. I. Salter, Saint Cloud, Minn., June 7, 1877.

I have only one instance of harrowing the ground in fall. My nearest neighbor put in a piece of new breaking with rye, first using seeder and then harrow. The result now stands that the rye is good and but few 'hoppers. The eggs were raked out almost or quite as thickly as the grain sown, and they were much thicker just beneath the loose top soil. The nature of our soil is a clay loam—yellow-clay subsoil.—[John Wise, Nebo, Platte County, Nebr., May 5, 1877.

2. PLOWING.—Next to harrowing this is one of the most generally available means possessed by the farmer of dealing with locust-eggs, and it is well to fully understand how it may be made most effectual in destroying them.

Experiments to test the effects of burying at different depths, and of pressing the soil.—The following series of experiments was made with eggs obtained at Manhattan, Kans., early in November, and similar in condition to those in the first series. Large tin cylindrical boxes, made of different depths, and varying from 4 to 8 inches in diameter, were used; and in order to hasten the result they were kept indoors at the temperature already mentioned. The soil in all the boxes was finely comminuted and kept in uniform and moderately moist condition. It was gently pressed with the fingers, so as to approach in compactness the surface-soil of a well-cultivated garden. In each instance the eggs were placed in the center of the box. A large number of eggs were buried at different depths out-doors where they were under natural conditions of soil-pressure and temperature. The soil was a tolerably stiff yellow clay, and was pretty well compacted by many heavy rains, after the frost was thawed out. The results of the outdoor experiments comport with those made in the boxes. The eggs being placed at every depth from 1 to 18 inches, and each batch covered with a wire screen, the result was accurately determined. All at 1 inch below the surface hatched; about one-third of those at 2 inches managed to escape, and none from any greater depth. Examined May 12, they had hatched down to a depth of 12 inches, and worked their way upward, and horizontally, seldom extending more than 1 inch in the former, or more than 2 inches in the latter direction. Most of those at greater depths were at that time unhatched. In looser soil they would doubtless have managed to push somewhat farther.

Experiment 30.—Ten egg-masses were placed just 1 inch below the surface in the center of a box four inches in diameter. The young began to appear January 30, when it was noticed that every one came up at the side of the box, between the earth and the tin, where there was more or less shrinking of the former from the latter. Upon pressing the earth more firmly around the border, the issuing of the young ceased. Upon examining the eggs, March 7, it was found that they had all hatched. A few of the young were still alive, and endeavoring to escape; the rest had died in the effort. They had made no progress upward through the pressed surface, but had pushed horizontally as the looser earth permitted.

Experiment 31.—From ten egg-masses, placed 2 inches beneath the surface, the young commenced issuing from the sides, as in the preceding experiment, January 31. None issued directly through the surface of the soil, and none issued after the border was pressed more firmly to the tin. Subsequent examination showed the soil penetrated in devious directions, but none of the insects had reached higher than within three-quarters of an inch of the surface.

Experiment 32.—Ten egg-masses placed 3 inches below the surface. The young began, January 31, to issue from the sides, as in Experiments 30, 31. Upon pressing the ground more firmly around the borders, none afterward issued, and subsequent examination showed that the young had tunneled the earth in tortuous passages toward the sides, and perished there, without reaching nearer than within an inch of the surface in the middle of the box.

Experiment 33.—Ten egg-masses placed 6 inches below the surface. On February 1 the young commenced to issue, as in the preceding experiments, from the side, and continued to do so till the 4th, when the earth was pressed more closely to the tin. None issued afterward. Subsequent examination showed that some had succeeded in working their way upward through the soil to within 2 inches of the surface; but most had reached the sides, and there collected and perished between the tin and the soil.

Other experiments, made in glass tubes where the movements of the insects could be watched, all produced results similar to those above given; and all point to the conclusion that where the newly-hatched insect has not the natural channel of exit (previously described) which was prepared by the mother, it must inevitably perish if the soil be moderately compact, unless cracks, fissures, or other channels reaching to the surface are at hand.

"The actual experience as to deep plowing under of the eggs is somewhat conflicting, and in some light, dry soils a good number of them will hatch late if turned under a foot; yet, from our own observations, and a vast amount of experience gathered together, we recommend it as profitable. If delayed till spring, it should be done just as the young begin to hatch, as it is then most effectual. The plowing will be effectual according as the soil is porous or tenacious, *and according as the surface is afterward compressed by harrowing and rolling.* From the experiments already recorded, it is obvious that, all other things being equal, a plowing of four to six inches will prove more effectual in spring, if the ground be subsequently harrowed and rolled, than deeper plowing with no subsequent comminution and compression."

The experience prior to 1877 is on record in various publications; but that of 1877 was most valuable, because, in many instances, township meetings were held the previous autumn to provide for combined action in the plowing up of roadsides and other public places where eggs had been laid. As may be seen by Mr. Whitman's report (App. 1), the good effects of plowing the eggs under deeply was very marked in Minnesota, wherever the work was thoroughly done. Even when turned under to a depth of five or six inches, the hatching, if it occurred at all, was too late to cause any fear. "Eggs plowed under in corn-land were found to be unhatched up to the 21st of June, but when brought to the surface they hatched at once; and, without any question, large numbers of eggs turned under in heavy grounds never hatched at all. At any rate, it ought to be learned from the present year, that with a good growth of wheat, we have nothing to fear from locusts that come struggling forth during the month of June."

The following experiences of correspondents are worthy of record here:

I plowed my orchard in the last days of March, and last week I was plowing some potatoes and I plowed out a good many 'hoppers, and in two or three minutes they would kick out and jump. I don't know how long they can live in the ground, but I don't think they can get out when they are plowed under.—[C. G. Brooks, Cherryvale, Montgomery County, Kansas, June 16, 1877.

The effect of plowing under the eggs quite deeply at any time before hatching, either in the fall or spring, has been to retard the hatching and give birds and other enemies a better chance to destroy them as they hatched. I think many never see the surface that are turned down with the plow.—[Robt. Milliken, Emporia, Kans., September 15, 1877.

Deep plowing is here the most effectual way of destroying the eggs.—[J. G. McGrue, Audubon, Minn., June 20, 1877.

I and my brother plowed a piece of land last fall that the 'hoppers had laid their eggs in, and not one per cent. hatched out. Time of plowing, September 9; depth of plowing, 6 inches; nature of soil, sandy loam.—[Thomas Nixon, Argyle, Sumner County, Kansas, November 5, 1877.

The land plowed early last fall by my neighbor, Thomas Bennett, was subsequently filled with eggs. He dragged and sowed it with wheat. It is now full of locusts. Mr. A. Burch, another neighbor, plowed late, and he has no locusts. My brother's farm was one-half plowed early, the other half late. The former hatched many locusts, the latter none.—[Seth Kenny, Morristown, Minn., June 9, 1877.

We plowed our land before many of the 'hoppers had hatched. It is high, rolling land, with considerable sand, and considerably worn from continued cropping for 19 years. We plowed about 15th of May. The largest hatch of the 'hoppers in any one day was May 27. They continued to hatch in considerable quantities up to June 10. Some few hatched after this date. But the most disagreeable part of it remains to be told. June 21 (the season was late for corn) we commenced to cultivate our corn, and immediately the young 'hoppers came out by millions. We have about twenty-four acres of corn in one field, and in the aggregate they make an "exceeding great army." Six acres of this corn was on timothy soil, that was very full of eggs.—[*Ibid.*, July 2, 1877.

Plowing, when properly done, is almost perfect destruction to the eggs.—[J. W. Bagby, Tabor, Clay County, Kansas, May 10, 1877.

So far as I can judge from my own experience and from observation, plowing the eggs under in the spring has destroyed most of them.—[T. C. Wells, Manhattan, Kans., June 27, 1877.

Plowing under only preserved the eggs to be hatched whenever a favorable opportunity presented.—[E. Snyder, Atchison, Kans., June 26, 1877.

Yesterday I examined a field closely that had been plowed under in early spring. I found thousands of nests of eggs hatched out and the young ones dead, having been unable to work their way out of the ground. There are many such instances here.—[Saml. Aughey, Lincoln, Nebr., May 4, 1877.

Believing it to be the duty of every good citizen to contribute all the information he may possess in relation to the destruction of the locusts, I will send you the practical experience of an observing farmer in this vicinity. In the spring of 1875, when the grasshopper committed such ravages in Western Missouri, William R. Hornbuckle relates that he had occasion to break up, for corn, a field that was in clover the year previous (1874), upon which the locust-eggs were more than usually thick. He plowed deeply the first of April and turned the eggs under so deep that they never hatched, or, if they did hatch, he never saw the locusts afterward. He thinks he plowed some eight or nine inches deep. The use of cultivators never disturbed the eggs. He examined the ground often during the season and found only the old eggs and no 'hoppers. One portion of the clover-field he failed to break until the eggs were hatched. In this the young locusts came so thick as to make the ground black, and while they were yet small he turned them under like the eggs, in the first instance. He saw very few of them afterward.—[Jno. B. Womall, Kansas City, Mo., January 23, 1877.

If the eggs are plowed under very deep in the fall, I believe many will fail to hatch or the young will not reach the surface when hatched. They should be thrown under about six inches in sandy, loose soil. Spring plowing has done but little if any good. It only causes them to hatch later in the season.—[A. H. Gleason, Little Sioux, Iowa, May 21, 1877.

Deep fall plowing seems to have destroyed many of the eggs. Every piece of breaking that was not fall-plowed suffered severely; that which was plowed and harrowed in the fall did not suffer much.—[W. J. Newell, Athol, Iowa, July 2, 1877.

Spring breaking of our lands remained perfectly good till upturned by second plowing one month to six weeks later.—[Jas. Moore, Bastrop, Tex., May 8, 1877.

Deep plowing retarded hatching. After all others were hatched the deeply plowed land was stirred, which brought on a new crop.—[G. B. Brown, Guilford, Kans.

Plowed in October, 1876; sowed to rye in November, on bottom land, but gravelly; cut the rye second week in July (prematurely) because of drought. As soon as the rye was cut the locust-eggs hatched in large quantities.—[Experience of M. K. Leverson, of Leverson's ranch, Colorado. From all we could learn the eggs were not turned under deeply.

3. IRRIGATION.—This is feasible in much of the country subject to locust ravages, especially in the mountain regions, where, except in exceptionally favorable locations, agriculture can be successfully carried on only by its aid, and where means are already extensively provided for the artificial irrigation of large areas. Where the ground is light and porous, prolonged and excessive moisture will cause most of the eggs to perish, and irrigation in autumn or in spring may prove beneficial. Yet the following experiments prove that it is by no means as effectual as is generally believed, and as most writers have assumed to be the case.

Experiments to test the influence of moisture upon the eggs.—The following series of experiments was made with eggs also brought from Manhattan, Kans. They were dug up in December, and were sound, and much in the same condition as those in the preceding series.

The water in all but the last three, or Experiments 23, 24, and 25, was kept in the office at the temperature already stated, and changed only when there was the least tendency to become foul. In the alternate submergence and draining, the eggs were submitted to the most severe hygrometric changes, the warm atmosphere of the room having great drying power.

Experiment 10.—Ten egg-masses kept under water in-doors from December 5 to December 26, 1876, the water becoming quite foul. They were then removed to earth and kept in a hatching temperature. They commenced hatching January 11, 1877, and continued to do so till February 5—all having hatched.

Experiment 11.—Twenty egg-masses kept under water in-doors from December 26, 1876, till January 2, 1877; then left dry till the 9th; then submerged again till the 16th, when they were drained again. On the 20th eighteen young hatched, and others continued hatching till the 23d, when they were submerged again. From the 26th to 30th a few hatched under water, successfully getting rid of the post-natal pellicle, and living for some hours afterward in the water. On the 30th they were drained again, and continued to hatch. On February 6 they were again immersed, and continued to hatch on the 7th. On the 15th, 22d, 29th, and March 7 they were alternately drained and immersed; but none hatched after February 7, and the remainder proved upon examination to have been destroyed, most of them being quite rotten.

Experiment 12.—Two egg-masses taken from the lot in experiment 11, on February 7, and placed in moist earth. Every egg subsequently hatched.

Experiment 13.—Two egg-masses taken from the lot in experiment 11, on February 22, and placed in moist earth. All hatched.

Experiment 14.—Twenty egg-masses alternately immersed and drained every two weeks from December 26 till March 6. None hatched, but three-fourths of the eggs were at this date sound, the embryon full formed and active as soon as released, but pale, and evidently too feeble to burst the egg-shell. The rest were killed and more or less decomposed.

Experiment 15.—Two egg-masses, after immersion for two weeks, were placed in moist earth. They began hatching twenty-two days afterward, and continued to do so for six days. It was subsequently found that only seven out of forty-eight eggs had collapsed and failed to hatch.

Experiment 16.—Two egg-masses immersed for two weeks and drained for two weeks; then placed in moist earth. Six days afterward they commenced hatching, and continued to do so for two days. Subsequently examined, twenty-eight out of fifty-four eggs had perished.

Experiment 17.—Two egg-masses alternately immersed, drained, and immersed again every two weeks, were placed in moist earth. They commenced hatching two days afterward, and continued to do so for twelve days. Upon subsequent examination, twenty-three out of fifty-two had perished.

Experiment 18.—Twenty egg-masses immersed from December 26, 1876, to January 16, 1877; then drained till February 6; then immersed till February 27; then drained again. On February 3, while dry, they commenced hatching numerously, and a few continued for two days to hatch while immersed. An examination, March 7, showed about half of them still alive, the rest rotten. On March 27 they were drained again, but none subsequently hatched—all having rotted and dried up.

Experiment 18*a*.—Two masses in same conditions as in experiment 18 till February 27 were placed in moist earth and all the eggs hatched March 7–12.

Experiment 19.—Twenty egg-masses immersed from December 26, 1876, to January 23, 1877; then drained till February 20; then submerged again. They commenced hatching on the 6th of February, and continued two days after the second submergence. On the 7th of March but about 5 per cent. had rotted. On March 20 they were drained again, but none subsequently hatched, except five eggs from two pods at once placed in earth.

Experiment 20.—Two egg-masses immersed for four weeks; then drained for two weeks; then immersed for one week; then placed in moist earth. They commenced hatching seven days afterward, and continued to do so for six days. Subsequently examined, one of the masses was rotten; the eggs in the other had all hatched.

Experiment 21.—Twenty egg-masses kept from December 26, 1876, in earth saturated with moisture. On February 23, 1877, they commenced hatching, and continued to do so till March 7, when all were found to have hatched, except one pod, which was rotten.

Experiment 22.—Twenty egg-masses, alternately placed every five days, from December 26, 1876, in earth saturated with moisture and in earth which was very dry. Commenced hatching February 14, and continued till March 7, when, upon examination, all had hatched, except nine of the pods, which were rotten.

Experiment 23.—Twenty egg-masses immersed and exposed outdoors December 26, 1876. From that time till April 9 the water was frozen and completely thawed at nine different times, the vessel containing them, which was of glass and admitted the sunlight, several times breaking. The changes were as follows: Frozen till January 10; then thawed till the 12th; then frozen till the 18th; then thawed till the 20th; then frozen till the 26th; then thawed till February 20; then partly frozen till the 22d; then thawed till the 26th; then frozen till the 27th; then thawed till March 5; then frozen till March 10; then thawed till March 15; then frozen till the 16th; then thawed till the 24th; then frozen till the 25th. Examined on the 7th of March, only one pod was found rotten; the others apparently sound. On the 9th of April all with the exception of twelve eggs were found rotten, the masses having become disintegrated and the eggs for the most part lying singly at the bottom.

Experiment 24.—Two egg-masses under same conditions as in experiment 23 till February 9, when they were brought in-doors and placed in earth. One was dried up on the 16th; the other commenced hatching on the 27th, and when examined on March 7 all the eggs in it were found to have hatched.

Experiment 25.—Two egg-masses under same conditions as in experiment 23 till February 27, when they were placed in earth in-doors. Examined March 7 they were found sound, and near the hatching point. On March 20 they commenced hatching.

Experiment 25*a*.—Two egg-masses under same conditions as in experiment 23, up to March 6, were then placed in earth in-doors. They commenced hatching March 23, and continued till April 3. Subsequently examined, but eight out of the fifty-four eggs were shrunken and dead.

Experiment 25*b*.—Two egg-masses under same conditions as in experiment 23, up to March 27, were then placed in earth, as above. April 14–20 ten hatched. Subsequently examined, the rest were found rotten.

Experiment 25*c*.—The twelve eggs remaining April 9 from experiment 23 were placed in earth. Five out of the twelve hatched April 20–26. The rest were subsequently found rotten.

These experiments establish a few facts that were somewhat unexpected. The insect is a denizen of the high and arid regions of the Northwest, and has often been observed to prefer dry and sunny places, and to avoid wet land, for purposes of ovipositing. The belief that moisture was prejudicial to the eggs has, for these reasons, very generally prevailed. The power which they exhibit of retaining vitality, and of hatching under water or in saturated ground, is, therefore, very re-

markable—the more so when viewed in connection with the results obtained in the succeeding experiments. That the eggs should hatch after several weeks' submergence, and that the young insect should even throw off the post-natal pellicle, was, to us, quite a surprise, and argues a most wonderful toughness and tenacity. After they had been dried and soaked for over six weeks, under conditions that approach those of spring, we found a good proportion of the eggs to contain the full-formed and living young, which, though somewhat shrunken, and evidently too weak to have made an exit, were still capable of motion. The water evidently retards hatching. An examination of the submerged eggs that remained unhatched long after others had hatched, which had been under similar treatment up to a certain time, and then transferred to earth, showed all the parts to be unusually soft and flaccid. Yet, when once life has gone, the egg would seem to rot quicker in the water than in the ground.

The results of experiments 23-25c prove conclusively that water in winter-time, when subject to be frozen, is still less injurious to the eggs.

Altogether, these experiments give us very little encouragement as to the use of water as a destructive agent; and we can readily understand how eggs may hatch out, as they have been known to do, in marshy soil, or soil too wet for the plow; or even from the bottom of ponds that were overflowed during the winter and spring. While a certain proportion of the eggs may be destroyed by alternately soaking and drying the soil at short-repeated intervals, it is next to impossible to do this in practice during the winter season as effectually as it was done in the experiments; and the only case in which water can be profitably used is where the land can be flooded for a few days just at the period when the bulk of the eggs are hatching.

4. Tramping.—In pastures or in fields where hogs, cattle, or horses can be confined when the ground is not frozen, many if not most of the locust-eggs will be destroyed by the rooting and tramping.

5. Collecting.—The eggs are frequently placed where none of the above means of destroying them can be employed. In such cases they should be collected and destroyed by the inhabitants, and the State should offer some inducement in the way of bounty for such collection and destruction. Every bushel of eggs destroyed is equivalent to a hundred acres of corn saved, and when we consider the amount of destruction caused by the young, and that the ground is often known to be filled with eggs; that, in other words, the earth is sown with the seeds of future destruction, it is surprising that more legislation has not been had, looking to their extermination.

One of the most rapid ways of collecting the eggs, especially where they are numerous and in light soils, is to slice off about an inch of the soil by trowel or spade, and then cart the egg-laden earth to some sheltered place where it may be allowed to dry, when it may be sieved so as to separate the eggs and egg-masses from the dirt. The eggs thus col-

lected may easily be destroyed by burying them in deep pits, providing the ground be packed hard on the surface. In the thickly-settled portions of Europe, where labor is abundant and cheap, this method may be adopted with some advantage, but it will scarcely be employed in this country, except as a means of earning a bounty, when, in the more thickly-settled sections, it will prove beneficial and give employment to young people and others who have nothing else to do.

DESTRUCTION OF THE YOUNG OR UNFLEDGED LOCUSTS.

It is with some degree of pride that we point to the fact that this part of the locust problem is solved. The experience of 1877 has added much to our knowledge of the practical and feasible ways of destroying the young locusts, and has firmly established the fact which we had previously maintained, that, with proper means, effort, and co-operation, the farmer, in the more fertile and settled portions of the country liable to their injury, may successfully cope with them; that, in short, he can protect his crops against them with about as little labor and expense as he must annually employ to protect most of these same crops from weeds. Farmers themselves were surprised at what could be accomplished by well-directed, intelligent effort; and it was the almost universal testimony that there need be, in future, no serious fear of the young insects, even where little effort has previously been made to destroy the eggs. In the destruction of the young, no methods that will not sweep them away in wholesale fashion have any value for our western farmers, however valuable they may be to the owner of a small flower or truck garden. It is for this reason that we have been able to profit so little by European methods, and have had to invent means suitable to our broad western fields and the extensive nature of our farming operations. The best that most European authors can advise is the killing of the insects with flattened implements or brush; while Gerstäcker and other writers devote page after page to prove the superiority over other methods of catching the insects with hand-nets—a method which, while doubtless of some utility in dense German settlements, would prove absolutely futile on our large and scattered prairie-farms and against the excessive numbers of the pests which our farmers have to deal with. While, therefore, we shall mention all available means that have been or may be employed, we shall devote more especial attention to those which are useful in a broad and general way in the field.

Experience has shown that the results of any particular measure will vary in different regions, dependent, to some extent, upon the nature of the soil, the condition of the crops, and the general characteristics of indigenous vegetation. Circumstances may also render some particular measure available and profitable to one farmer where it would be unprofitable to another. For convenience, the means of accomplishing the desired result may be classified into: 1. Burning. 2. Crushing. 3. Trapping. 4. Catching. 5. Use of destructive agents.

1. BURNING.—This method is, perhaps, the best in prairie and wheat-growing regions, which compose the larger part of the area subject to devastation by this locust. In such regions there is usually more or less old straw or hay which may be scattered over or around the field in heaps and windrows, and into which the locusts, for some time after they hatch, may be driven and burned. During cold or damp weather they congregate of their own accord under such shelter, when they may be destroyed by burning, without the necessity of previous driving. Much has been said for and against the beneficial results of burning the prairies in the spring. This is chiefly beneficial around cultivated fields or along the roadsides, from which the locusts may be driven, or from which they will of themselves pass for the shelter the prairie affords. Scarcely any eggs are laid in rank prairie, and the general impression that locusts are slaughtered by myriads in burning extensive areas is an erroneous one, at least in the Temporary region.

In burning extensive prairies after the bulk of the locusts hatch, the nests and eggs of many game birds are destroyed; but as the birds themselves escape destruction on the wing, they may and do return and nest again, while, on the contrary, many injurious insects, like the Chinch-bug, for instance, are killed, so that, even leaving the locust question out of consideration, the burning proves beneficial by exterminating other noxious insects, and has some advantages from an agricultural point of view.

As locusts disperse more and more from their hatching-grounds into the prairie as they develop, burning the grass in spring is beneficial in proportion as it is delayed.

Machines for burning have been used in several localities with considerable success. Mr. J. Hetzel, of Longmont, Colo., has employed a machine drawn by horses. It is 12 feet long, from 2 to 2½ feet wide, made of iron, and set on runners 4 inches high. An open grate on the top of the runners is filled with pitch-pine wood, a metal sheet covering the grate to keep the heat directed downward. The grate is generally made with a net-work of heavy wire, such as telegraph wire. Two men and a team can readily burn from 10 to 12 acres a day, and kill two-thirds of the insects, but for this it requires a hot fire.

Mr. C. C. Horner gives a more detailed description, in the *Colorado Farmer*, of a machine of somewhat similar construction:

It consists of three runners, made of 2 by 4 scantling, 3 feet in length, to be placed 6 feet apart, making the machine 12 feet wide; runners to be bound together by three flat straps or bars of iron (the base being 12 feet long). Across the top, bars of iron hold the runners firmly together, and form a frame across which wire can be worked to make a grate to hold fire. The upper part of the runners should be hollowed out so that the grate may slide along within two inches of the ground. A sheet-iron arch should be set over this grate to drive the heat downward. This machine is very light, and can be worked with one horse. Pitch-wood is best adapted to burning, and can be chopped the right length and size and left in piles where most convenient when needed. This machine is intended to be used when the little 'hoppers just make their appearance along the edge of the grain, going over the ground once or twice each day, or as often as necessary to keep them killed off. The scorching does not kill the grain but makes it a few days later. This is certainly the cheapest, as well as the most effectual, manner of getting rid of this pest.

Hand-burners, consisting of any form of pan or grate, or wire sieves, with handle attached, to hold combustible material, will do excellent service in gardens and small inclosures.

There is another method by which large numbers of locusts can be burned, consisting merely of a bundle of rags or tow, which, after being attached to long wire or iron rods and saturated with kerosene, can be ignited and carried over the field. This method has been quite satisfactorily used in Colorado. A stout wire, say forty feet long, is thoroughly enveloped in rags soaked in coal-oil. A small wire is wound around the rags to keep them in place, and the simple device is complete. Two men carry this rope, after set ing fire to the rags, across the field to and fro until the fuel is exhausted, and as it is not necessary to pass over the same ground more than once or twice, a large field of grain can be thus protected during the half hour or so that the rags burn. The effect is that of a miniature prairie fire.

Under this head may be mentioned a machine constructed by Mr. Kimball C. Attwood, of Syracuse, N. Y. (patent No. 193,105, dated July 17, 1877), for destroying the insects by sulphur fumes. The machine is too expensive and complicated to come into general use, especially as it is less effectual than some of the simpler ones. The principle of the invention consists in attaching to the axle of the machine a light stove, and connecting the same with a blower or bellows by means of a tube. Surmounting this tube, and close to the stove, is situated the hopper for the reception of the destroying compound (sulphur), while the lower section of the stove is connected with an escape-pipe having attached thereto a series of flexible tubes, by means of which the fumes of the compound are carried to the ground. Attached by suitable means to the rear of the axle is a horizontal bar, to which is secured the apron or cover designed to prevent the escape of the fumes after being delivered by the flexible tubes.

Other machines have been constructed, having troughs or wire receptacles attached, in which the locusts are deposited and ultimately destroyed by means of sulphur fumes or hot water. But as these remedies are applied by hand, they will be classed under the head of *Catching*, &c.

2. Crushing.—To destroy locusts satisfactorily by this means, can only be advantageously accomplished where the ground is smooth and hard. Where the surface of the ground presents this character, heavy rolling can be successfully employed, especially in the mornings and evenings of the first eight or ten days after the newly-hatched young have made their appearance, as they are generally sluggish during those times, and huddle together until after sunrise. It is also advantageously employed during cold weather at any time of day, since the young when the temperature is low seek shelter under clods, &c. In various parts of Europe and Asia, flat, wooden, spade-like implements are extensively used for crushing young locusts. Large brushes,

weighted down with stone and drawn by horses, were in some instances used last summer, but with less success than was anticipated.

Several machines, most of them patented, were for the first time used during the past year to further the crushing of the young, and while none of them are likely to take the place of the more simple methods of catching, to be presently described, we nevertheless feel that it devolves upon us to describe some of them. That represented in the accompanying illustration was invented by Mr. George B. Drum, of Syracuse, Nebr. (Patent No. 187,258, dated February 13, 1877). Fig. 67 is a vertical section on line *x*. Fig. 68 is a plan view with a part of the top removed, showing the mechanism.

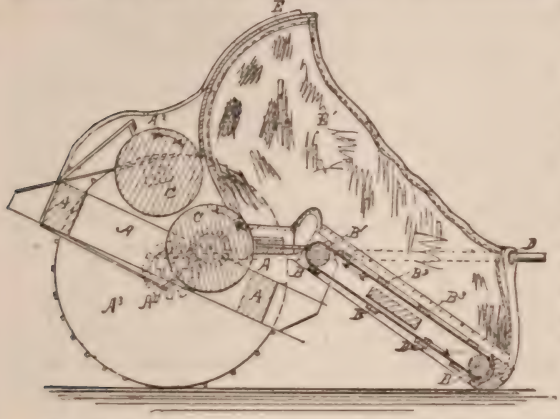

FIG. 67.—THE DRUM LOCUST-CRUSHER: Vertical section.

To the front of the principal frame A of the vehicle is attached, by a hinge or movable joint, a scraper-frame, B. The front edge of B is carried along or near the ground for the purpose of collecting and starting the insects from the ground. Within the frame B are two rolls, B^1 B^1, carrying an endless apron, B^2, of canvas or other flexible material. On B^2 are secured one or more strips of wood or metal, B^3, the purpose of these strips B^3 being to keep the canvas straight, and carry the insects forward upon the apron, and prevent their rolling out and escaping. The rolls B^1 and apron B^2 are driven by a belt from one of the wheels A^3 of the vehicle. Upon the frame A is secured a brush, A^1, to sweep the insects and drive them toward the rolls C, and also to prevent them from being carried around with the apron B^2. Upon the frame A, and immediately in the rear of the brush A^1, are placed two or more crushing-rolls, C C, of wood or metal. These rolls C C run in boxes, connected by the spring *c* for the purpose of giving the rolls C C a yielding or elastic pressure upon each other. The rolls C C are driven by gearing from one of the wheels A^3 of the vehicle, and in such direction that

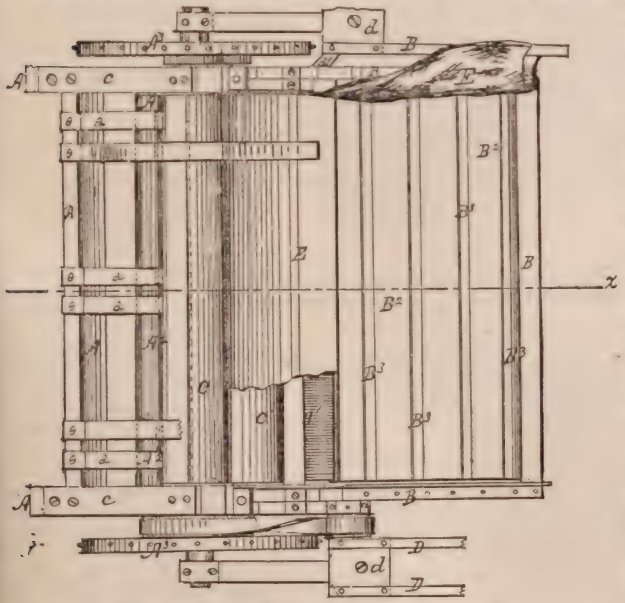

FIG. 68.—THE DRUM LOCUST-CRUSHER: Plan view.

the insects passing over the brush are drawn through the rolls C C and killed, falling upon the ground, or if it is desired to collect the insects for any purpose, a bag may be attached to the frame A, by hooks or otherwise, below the rolls C C. Upon the frame A are screwed, by means of springs or elastic connections *a*, two scrapers, A^2, of metal or wood, which, bearing upon the surfaces of the rolls C C, serve to keep them clean and prevent the insects from being carried around them and clogging the machine. To the top of the frame A is secured a light frame or top, E, of wood or metal, covered with the same or with canvas, and having two side-wings, E′ E′, also of canvas. The side-wings E′ are also secured to the frame of the apron B^2, forming with that and with the top E a hopper of entrance to the rolls C C, of large area, to catch the insects and prevent their flying over the machine and escaping. The wings E′ are also attached to the shafts D D, or to the harnesses of the horses, to assist in spreading and enlarging the area of the hopper. The frame A is carried upon two wheels, A^3 A^3, which have projections upon their periphery to give them the necessary driving-power required by the rolls B and C. To each side of the frame A are secured brackets *a*′, which extend back and are attached to the outer end of axles of A^3 A^3. Upon the brackets *a*′ are pivoted shafts D, by means of which horses can be harnessed to the vehicle for the purpose of drawing it, the pivots *d* giving the horses the necessary freedom and independence of motion, and also allowing the side-wings E′ to be drawn out or spread out by the action of the horses.

Another is that invented by Mr. Michael H. Simpson, of Boston, Mass. (Patent No. 198,420, dated December 18, 1877. Fig. 69 represents a perspective view of the machine; Fig. 70 a sectional view of the same as shown in the preceding; and Fig. 71 a sectional view of the same arranged for the removal of the insects.

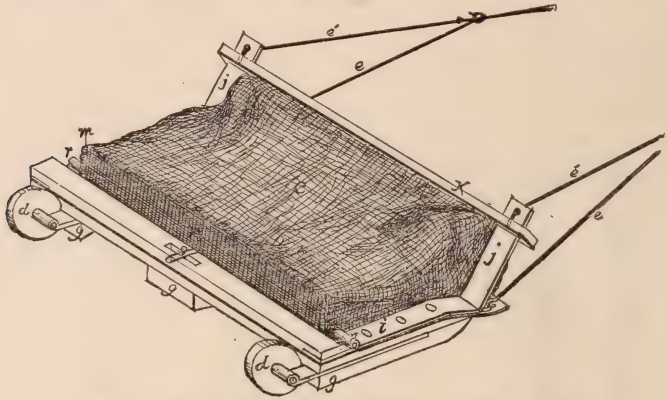

FIG. 69.—THE SIMPSON LOCUST-CRUSHER: Perspective view.

The invention consists, as a whole, in a receptacle for insects, composed of a platform adapted to be drawn or propelled along the surface of the ground, and a flexible hood or cover located on said platform. The receptacle thus formed is adapted to be opened at its front, and held open by the draught which moves the apparatus, and to be automatically closed at its front when the apparatus stops; and the receptacle is adapted to be opened at its rear for the removal of the insects after they have been killed by being crushed against the platform.

FIG. 70.—THE SIMPSON LOCUST-CRUSHER: Sectional view.

In the drawings, A represents the grasshopper catcher or receptacle, which is composed of a rigid platform, *b*, and a flexible hood or cover, *c*, located thereon. The platform *b* is mounted on trucks *d d* at its rear side, and has draught-ropes *e e* attached to its forward side, said ropes being adapted for attachment to a horse. The platform is, preferably, from five to seven feet long, and

FIG. 71.—THE SIMPSON LOCUST-CRUSHER: Sectional view, when ready to remove the insects.

is composed, preferably, of boards, making a tight flooring, and resting on transverse cleats *g g*, the forward ends of which are rounded and rest upon the ground. The forward side of the platform is provided with a downwardly-inclined metallic flange or scoop, *h*.

The hood or cover *c* is composed, preferably, of coarse bagging or other textile or flexible material, and is attached firmly to the ends of the platform, preferably by means of metallic strips *i*, which are screwed to the platform, the ends of the cover being interposed between the platform and the strips *i*.

j j represent parallel inclined standards, which are rigidly attached to the front side of the platform, and project upwardly and outwardly therefrom, the standards being, preferably, portions of the strips *i*, as shown in Fig. 1.

k represents a bar, which is somewhat longer than the platform *b*, and is adapted to slide up and down on the standards *j*, the bar being provided with slots, through which the standards pass. The forward edge of the hood or cover *c* is attached in any suitable manner to the bar *k*, so as to rise and fall with the latter. The bar *k* is connected to the draught-ropes *e* by short ropes *e'*, which pass through orifices in the upper ends of the standards *j*, and are so arranged that the draught which moves the apparatus will draw the bar upwardly, so that the receptacle is held open, as shown in Figs. 1 and 2, while the apparatus is in motion. When the draught ceases and the apparatus stops, the bar *k* falls, and thus automatically closes the receptacle, as shown in Fig. 3. I prefer to employ a spring, *l*, to facilitate the descent of the bar *k*, this spring being attached at its ends, preferably, to a stationary object near the rear edge of the platform, and to the underside of the hood or cover near the forward edges thereof, as shown in Figs. 2 and 3. This spring, however, may not be necessary when the bar is sufficiently heavy to descend readily by its own weight.

It will be seen from the foregoing that when the apparatus is put in motion the front of the receptacle is automatically opened, and the grasshoppers or other insects on the surface of the field over which it is drawn are gathered or "scooped" into the receptacle.

I provide the rear side of the receptacle with a rigid frame, *m*, to which the hood *c* is attached. This frame incloses a sheet of fine netting, *n*, which forms a reticulated barrier at the rear of the receptacle, and allows the air to pass freely through the receptacle when it is in motion, but arrests and prevents the escape of the insects.

Another machine that may be mentioned in this connection is that invented by Mr. Charles Hoos, of Arago, Nebr. (Patent No. 187,855, dated February 27, 1877.) In the accompanying illustrations, Fig. 72

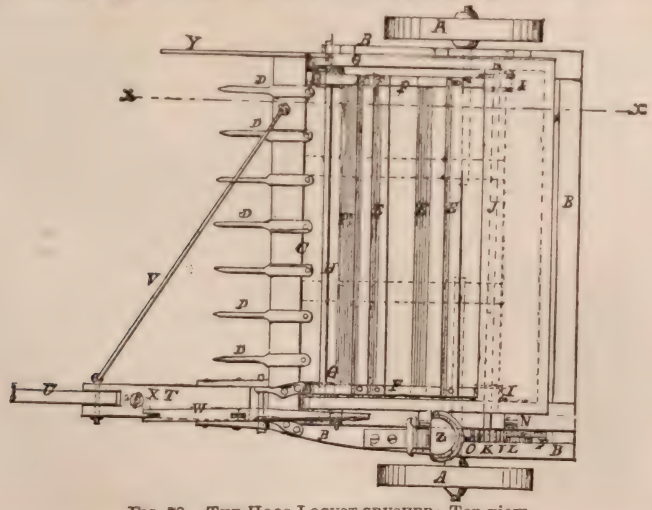

FIG. 72.—THE HOOS LOCUST-CRUSHER: Top view.

represents a top view of the machine; Fig. 73 is a vertical section of the same taken through the line *x x;* and Fig. 74 is a side view. The following detailed description illustrates the construction and working of the machine:

A are the wheels, one of which revolves upon an axle attached to the frame B, and

the other is rigidly attached to its axle, which revolves in bearings attached to the frame B. To the frame B is attached the platform C, to the front of which are attached a number of guards or fingers, D, which are curved upward, and are designed to enable the machine to pass over obstructions, and to cause the grasshoppers to rise from the ground and fall upon the platform C.

The platform C is grooved or rabbeted, as shown in Fig. 73, and is made highest in the center, and declines toward the front and rear, that the grasshoppers may be crushed against the shoulders of said rabbets or grooves by the cross-bars E, attached to the endless belts F. The cross-bars E are rounded off upon their forward corners, so that they may pass over the grooves or rabbets of the platform C. The endless belts F pass over pulleys G, attached to a shaft, H, the journals of which work in bearings in the forward parts of the side boards of the platform C, and over pulleys I, attached to a shaft, J. The journals of the shaft J revolve in bearings in the rear parts of the side boards of the platform C, and to one of said journals is attached a gear-wheel, K, the teeth of which mesh into the teeth of the gear-wheel L, attached to the journal of the roller M. To the journal of the roller M is also attached a gear-wheel, N, the teeth of which mesh into the teeth of the gear-wheel O, attached to the revolving axle of the wheel A. The teeth of the gear-wheel N also mesh into the teeth of the gear-wheel P, attached to the journal of the roller Q, placed parallel with the roller M. The rollers M Q are placed at the rear edge of the platform C, so that any grasshoppers that may not be killed by the cross-bars F may be crushed by and between the rollers M Q.

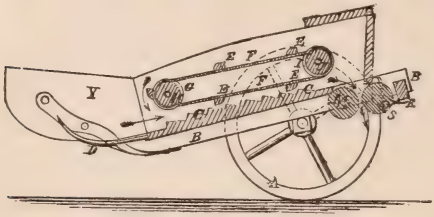

FIG. 73.—The Hoos Locust-crusher: Vertical section.

The journals of the forward roller M revolve in stationary bearings attached to the frame B, and the journals of the rear roller Q revolve in movable bearings, which are held forward by springs, R, so that the said roller Q may adjust itself according to the number of grasshoppers passing through the machine.

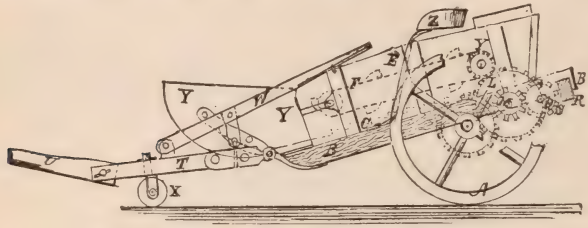

FIG. 74.—The Hoos Locust-crusher: Side view.

To the frame B are attached scrapers S, to scrape off the crushed grasshoppers from the rollers M Q. To one of the forward corners of the frame B is hinged the end of the draw-bar T, to the forward end of which is hinged the tongue U. The draw-bar T is strengthened against side draught by the brace V, the forward end of which is attached to the forward part of the said draw-bar T, and its rear end is attached to the frame B, near its other forward corner.

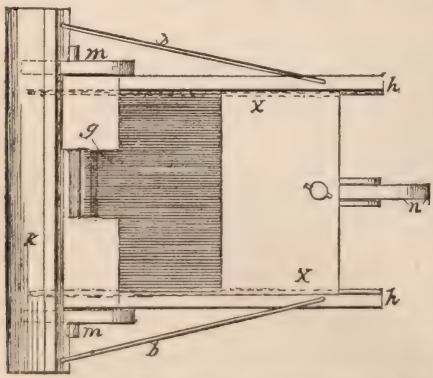

FIG. 75.—The Hansberry Locust-crusher: Top view.

To the draw-bar T is attached a lever, W, which extends back into such a position that it may be conveniently reached and operated by the driver from his seat, to raise and lower the forward edge of the platform C. The lever W may be secured in place, when adjusted, by catches attached to the frame B, or to the side board of the platform C. The draw-bar T is supported by a small caster-wheel, X, attached to it.

To the other corner of the frame B is attached a guard-board or shield, Y, to prevent the grasshoppers from escaping, and to cause them to fall upon the platform C. Z is the driver's seat, the standard of which is attached to the frame B, and is provided with rests for the driver's feet.

We witnessed the working of a machine invented by Mr. T. K. Hans-

berry, of Padonia, Kans. (Patent No. 188,359, dated March 13, 1877), intended to crush the insects by means of movable wooden bars. It

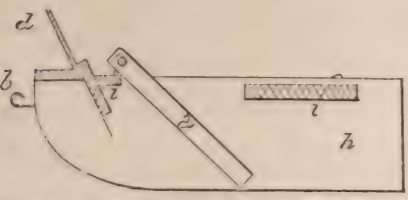

FIG. 76.—THE HANSBERRY CRUSHER: Sectional view.

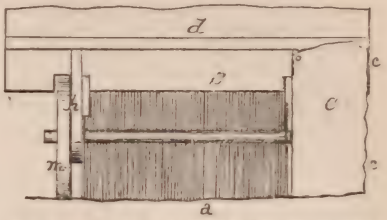

FIG. 77.—THE HANSBERRY LOCUST-CRUSHER: Front view.

does not prove very successful, however, except on the very smoothest ground. Fig. 75 is a top view, when mounted on wheels or runners; Fig. 77 represents the front. Fig. 76 is a sectional view of the machine when on runners, with knives or bars attached; and Fig. 78 shows the slide attached close to the axle to close the angle formed at the side by the ground and the knives or bars, when the machine is mounted on wheels.

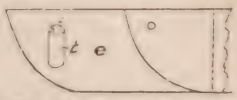

FIG. 78.—THE HANSBERRY CRUSHER: Slide attachment.

The invention consists in the novel construction and arrangement of a system of knives or bars attached by one end on a pivot or hinge so as to hang at an angle from a suitable frame, while their opposite ends drag freely on the ground, accommodating themselves to the inequalities of the surface, and, as the machine moves forward, crushing and destroying the insects (the frame may be mounted on wheels or on runners, as shown by Fig. 75 in the accompanying drawing); also, in the slide or cover, Fig. 78, used, when the machine is mounted on wheels, to close the angle between the axle and the knives or bars laterally, and in other details of construction hereinafter claimed.

a are the knives or bars, which may be constructed of wood or iron or of any other suitable material. Fig. 75, as already stated, shows the machine ready for operation. A section of the cross-bar *i* of the frame in front is cut away to show in what manner the knives or bars may be attached to the frame *h h*. The dotted lines *x x* indicate the place of the runners when the machine is to be operated without wheels. The rods *b' b* end with a hook, to which the draught is applied. To each of these hooks a horse is to be attached. The animals' heads are to be separated by a jockey-stick, so as to cause them to walk a little outside and in front of the line of the wheels or the runner. The animals will thus be separated from 12 to 15 feet, and even 18 feet, according to the width of the machine and its consequent destructive capacity. Each horse will be covered from the back down to the feet on the outside with a canvas cover to be attached to the harness. This canvas will extend to the rear and be connected to the canvas wings *c c*, as shown in Fig. 77 in the drawing. When the horses are covered in this manner and attached to the machine as described the insects will be gathered and forced toward the center between the horses as the machine advances, where they will be caught and crushed by the knives or bars *a*, or cut to pieces when these bars are armed with steel blades at the ends. The hood or dash *d*, Fig. 76, is placed at the extreme front, above the throat *s*, after the manner of a dash on a one-horse sleigh, to catch any insect that might attempt to take wing as the machine moves forward. In attempting to rise they will come in contact with the hood or dash and be thrown to the ground, where they will be destroyed by the advancing knives or bars. The dash or hood may be made of wood, tin, sheet-iron, or any suitable material—even canvas may be used. To prevent the escape of the grasshopper laterally or at the side through the angle or space formed by the bars and the ground when the machine is mounted on wheels, the slide or cover *e*, Fig. 78, is employed attached to the axle *f* with the slot *t*. The slide or cover may be jointed, as shown in the figure, or in a single piece. By being jointed it will have a single motion up and down, thus accommodating and adjusting itself to the inequalities of the ground. The upright parts of the frame *h* are held in position by cross-pieces *i*, and in front is a cross-beam, *k*, which support may carry canvas wings *c c*.

It will be readily understood that when my device is used without wheels it is supported upon runners or parts *h*, in which case the slide *e* is not used, but when used

upon wheels *m* the slide *e* fills up the space otherwise occupied by the runners *h* and prevents the escape of the insect laterally. In the rear of the machine is a pivotal wheel, *n*, which supports a portion of the weight of the frame and renders the machine easily turned in any direction.

It will be evident that the knives or bars *a* may be greatly modified or changed in construction without departing from the spirit of my invention, as, for instance, they might be armed with steel blades at their bearing on the ground to cut up as well as crush the insects. They might be hinged in groups or in sections. Sufficient weight may be given to each particular knife or bar by a spring or by loading them. It is believed they should be pivoted, as this will give the heaviest bearing at the point of contact on the ground.

As the device is drawn along either on wheels or on runners, as may be most convenient, and according to the particular mode of construction, the insects are gathered into the space between the horses and between the runners *h* or the slide *e*, where they are crushed and destroyed by the knives or bars *a*, the knives or bars also accommodating themselves to the configuration of the ground, easily passing over obstructions, and rendering it almost impossible for the insect to escape destruction. The knives or bars *a* are held in place by a rod, *g*, passing through a hole in the ends of each, the rod passing through the sides of the frame *h h*, in which it is secured by means of suitable fastening.

Mr. Elisha Kenworthy, of Walnut, Iowa, has invented a machine (Patent No. 186,970, dated December 5, 1876), which can be placed under this class of machines. Fig. 79 presents a vertical section of the invention and Fig. 80 a plan view of the same. The following description will explain the parts and operation (Figs. 79, 80):

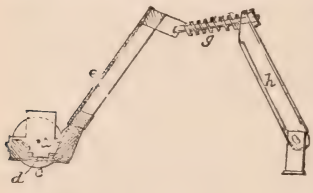

FIG. 79.—THE KENWORTHY LOCUST-MACHINE: Vertical section.

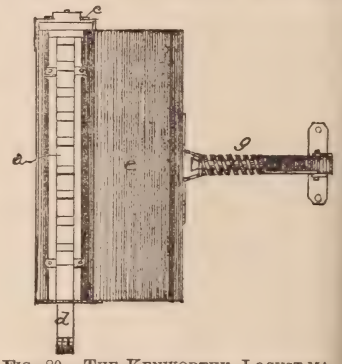

FIG. 80.—THE KENWORTHY LOCUST-MACHINE: Plan view.

a represents a suitable trough, made of any desired length, width, or material, and which has a number of slots made across its bottom. This trough is designed to be placed across the front of the reaper platform, so as to be in line with the pitman, and which has a supporting-wheel, *c*, on its outer end, to enable it to run smoothly over the ground. Working back and forth in this trough, operated by the pitman, is the sickle-bar *d*, which likewise has a number of slots or holes through it, but wider than the slots in the bottom of the trough. This sickle may be made of one single piece or two horizontal pieces, and have cross-bars secured to them, the cross-pieces being beveled on their under sides, and the sides of the slots in the bottom being similarly beveled on their under edges. The rear side of the trough is higher than the front, is inclined backward, covered with sheet-metal, and has hinged to it the inclined platform *e*, which is also covered with sheet-metal, so as to cause the grasshoppers to slide down into the trough. This platform is held in position by the spring-rod *g*, which has its rear end fastened to the top of the brace *h*, which brace is fastened to the platform or some other support. The spring is used to impart a vibratory motion to the platform as the machine is drawn along, so as to shake the hoppers down as fast as they light upon its front. As rapidly as the hoppers fall into the trough they are crushed to death by the rapid reciprocations of the sickle, and then forced out of the bottom of the trough through the openings.

In using my device the cutter-bar or blade is disconnected from its pitman, so that it will no longer operate when the machine is in motion, and then my device, as above described, is placed upon the front edge of the platform, secured in position, and its sickle-bar connected to the pitman. When the mowing or reaping machine is drawn over the ground the motion of the machine causes the bar *d* to reciprocate back and forth and kill the insects as fast as they fall into the trough.

Numerous communications upon this subject have been received, some of which, if not all, are or may have been successful on a small scale. Others, if carried out, and the contrivances built and given a fair trial, might be of especial benefit.

Mr. J. C. Melcher, of O'Quinn, Texas, constructed one which he describes as follows:

It is constructed on the hand-lawnmower style, mounted on light wheels, a disturbing rim 8 or 10 feet long, passing low over the ground to stir the 'hoppers up. Just behind the disturber are two sheet-metal rollers, one of which drives an endless band. As soon as the 'hoppers jump over the disturber, the band catches them and crushes them between the rollers. The rollers, being of sheet-iron, are elastic enough to press uniformly at any given point. A rack of wire web or cloth ascends over the top of the machine to prevent the 'hoppers from escaping. It is operated by two men pushing the machine before them.

Mr. John Wise, of Nebo, Platt County, Nebraska, says (in a letter dated May 26, 1877) a good machine can readily be made by having "two revolving rollers mounted on wheels, the rollers to be four or six inches above ground, so arranged, if need be, to be adjusted either higher or lower, the upper to revolve on the top of the lower," &c. To a contrivance of this sort handles could be attached for pushing; and with the addition of a frame covered with cloth or muslin projecting forward and outward.

In addition to the preceding contrivances for crushing locusts is one invented by Mr. F. Peteler, of Minneapolis, Minn.

Fig. 81 represents a front view, and Fig. 82 a side view, of the same machine.

In a communication from the inventor, dated June 8, 1877, the following description is given: The machine is intended to be drawn by horses, the drawing representing one to be drawn by a team. "The frame is mounted upon two wheels. The front is a sheet-iron platform, over which revolves an elevator made of slats, which carry the locusts into boxes, where they pass between rollers, are crushed, and fall to the ground. The sides and top or back are wire screws, the whole forming a scoop 16 feet long (on the bottom 19 feet), 8 feet high, the top of which can be lowered or raised according to the height of the grain or grass."

We annex a more detailed description:

AA, driving-wheels; B, guiding-wheel; D, setting-lever; *d*, retaining-post; G, endless carrier; H*h*, gearing for elevator and crushing-shaft; I, crushing-rollers; *L*, set-screw to spiral spring; *l*, spiral spring to press rollers together when necessary; N, slats on endless chain with sheet-iron projections to hold the locusts; M, drag-chain (or strips of light wood) to stir the locusts.

Mr. Peteler believes that, with a single horse machine, 40 or 50 acres can be gone over in a single day, and by changing horses more can be done; but we, unfortunately, had no opportunity to test the practical working of the machine, as, by the time it was perfected, simpler and satisfactory methods were extensively being employed in Minnesota, and the inventor did not feel encouraged to manufacture his machine. Indeed, its expense is too great to warrant its manufacture, except to order by clubs of farmers. To use Mr. Peteler's own words: "This machine is intended for local or State authorities to use on uncultivated lands adjoining farms and unsettled prairies, in order to destroy the insects during the entire season; for that purpose there should be

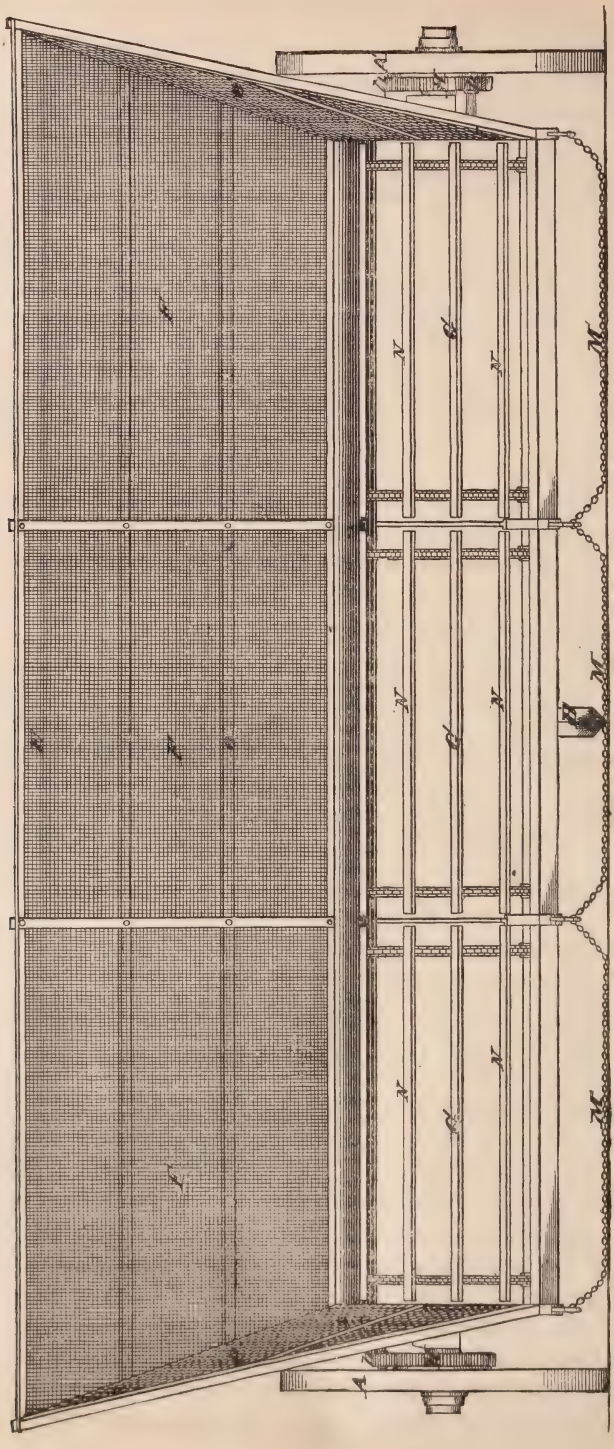

FIG. 81.—THE PETELER LOCUST-CRUSHING MACHINE: Front view.

proper organization, with camp outfit, &c., to follow up the swarms, loading the machines on wagons, and battle with the 'hoppers morning and evening, when they are comparatively sluggish. These machines are not designed as temporary contrivances, believing that we shall have the scourge several seasons in some parts of the State, and they should be made strong and durable." Instead of paying bounties from the State treasury for the locusts, Mr. Peteler would have the State aid the farmers by investing in these machines. "Fifty thousand dollars advanced to farmers will place, at $40 each, 1,250 one-horse machines

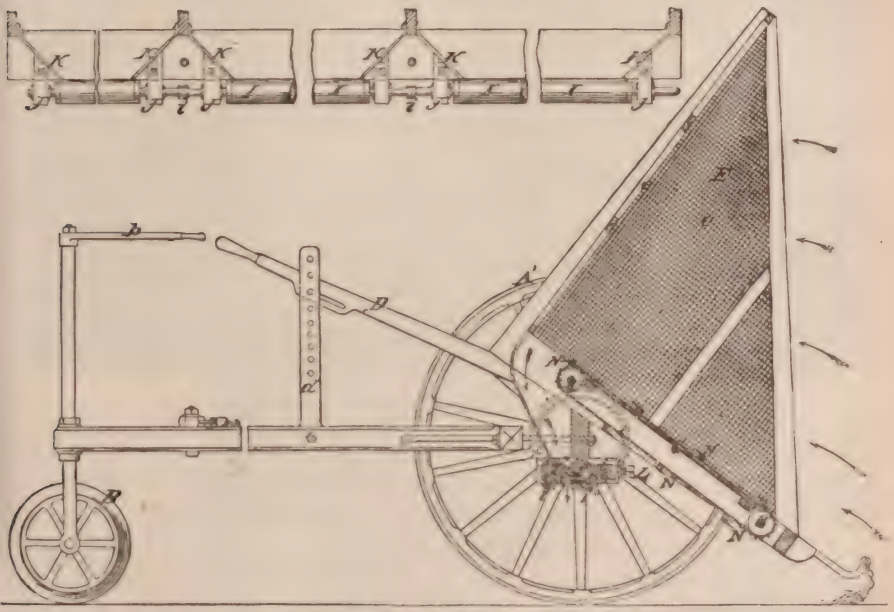

FIG. 82.—THE PETELER MACHINE: Side view.

in their hands to keep their grain-fields clear. If they use them only 60 days during the season, and go over only 40 acres per day, destroying but one-half bushel per acre (frequently they would destroy 8 to 10 bushels per acre), they would send 25,000 bushels daily, or 1,500,000 in 60 days, where bad 'hoppers go. That money would be returned to the State in four to six months by the farmers, provided the State and local authorities will do their duty by destroying the pests on uncultivated lands."

Under this head we may mention the curious suction-fanning machine invented by Mr. J. A. King, of Boulder, Colo., and one of which, purchased by Mr. T. C. Henry, of Abilene, Kans., we had the opportunity to fully test. It consists of two large tin tubes (Fig. 83, A A), about 8 inches in diameter, with flattened, expanded, and lipped mouth-pieces (B) running near the ground. This horizontal opening or mouth is about 7 feet long. The tubes connect at the upper extremity with a chamber

(C), in which is a revolving fan which makes about 1,200 revolutions per minute. The tubes and fan, with the gearing, are placed in a frame (D) 5 by 10 feet, mounted upon two large driving-wheels (E E).

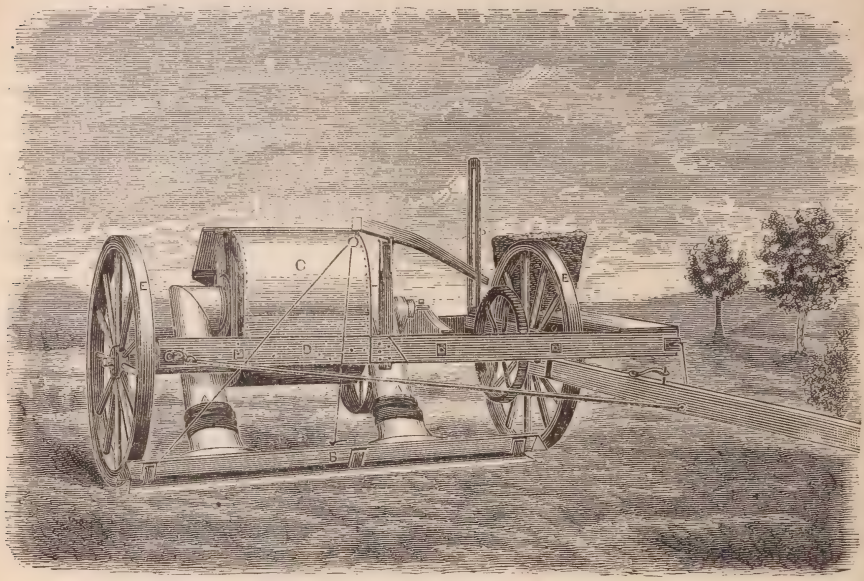

FIG. 83.—THE KING SUCTION-MACHINE: Front view.

The air-current made by the revolving fan creates a suction at the mouth, which draws the insects up the tubes and into the chamber. They are then thrown by the fan upon a wire screen, and from thence drop into a kind of hopper which conducts them to a bag. The wire screen rapidly chokes up and must be frequently cleaned. Most of the locusts are crushed and mangled by the rapidly revolving fan, so that the screen may be removed entirely and the locusts thrown out behind. This allows a freer draught and causes a greater suction. This machine can be made for about $50, and it works well on smooth ground or in a wheat-field while the wheat is yet short. It is somewhat difficult to keep the lips close enough to the ground. The principle of the machine is a good one, and we see no reason why some cheaper modification of it should not be quite generally used early in the season, especially in Colorado, where there is so much hard, smooth ground around the cultivated fields. The lips might be protected and rendered less liable to bend and get out of order by moving on runners made to extend some distance in front.

Finally, a machine which we saw in Colorado, and which was put up by J. S. Flory, of Greeley, Colo., is worthy of mention in this connection; for, while it may be used with coal-tar, it is essentially a catching and crushing machine. The Colorado *Sun* thus speaks of it:

The main feature of this invention is a revolving platform of heavy canvas or wire-cloth which runs between two horizontal rollers. Long arms reach forward, which

FIG. 84.—THE KING SUCTION-MACHINE: Side view, in operation.

support a revolving reel; from these arms downward extend sheet-iron sides, over the top a canvas covering; all so constructed as to form a large wide mouth, into which the 'hoppers are driven by the arms of the revolving reel and carried between the two rollers and crushed. Horizontal strips running along the rollers serve to keep the rollers and platform clear of the crushed grasshoppers. The whole machine is supported on two main wheels about the middle, and two smaller ones in front. Extending back is a frame or cross-bar, to which one or two horses may be hitched to push the machine forward, or it may be operated by hand. The front of the platform runs close to the ground, and by bearing down at the rear by the driver, it can easily be lifted over any obstruction that may be in the way. The machine can be raised or lowered in front to suit the crop over which it is run.

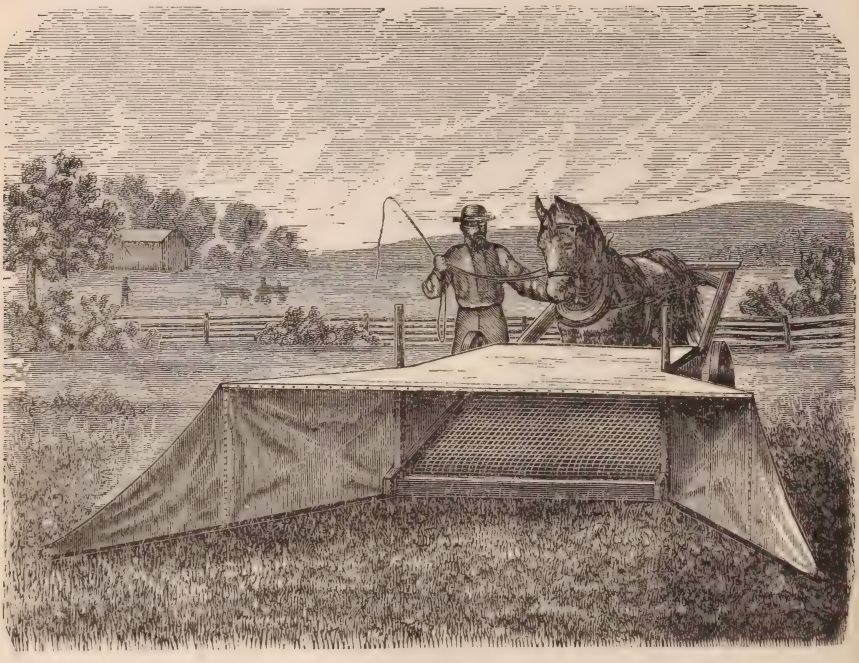

FIG. 85.—THE FLORY LOCUST-MACHINE: Front view, in operation.

This invention will destroy the grasshoppers without the necessity and expense of using oil or tar. The patent, we understand, also covers the combinations of a receptacle immediately under the rollers, into which the grasshoppers are carried, and into

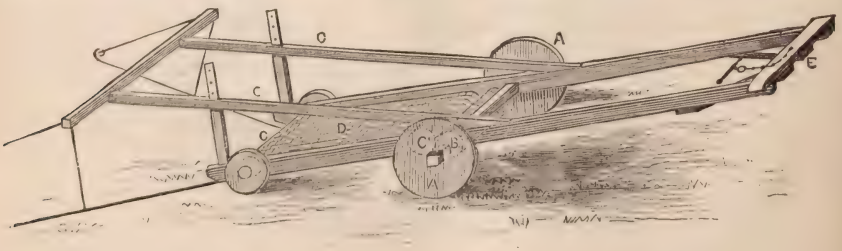

FIG. 86.—THE FLORY LOCUST-MACHINE: Side view of frame.

which, if need be, water and oil may be kept, and also a long narrow hopper (just over the rollers), into which coal-tar may be put and allowed to run through on to the

platform, thus making it a *self-tarring machine*. Either of these combined methods of destroying the 'hoppers may be used as the farmer may choose. The machine is so simple in construction that any ordinary workman can put them up at a comparatively small price. The machine may be made of any size desired, from a small hand-machine to one a rod or more in width.

Fig. 85 represents a front view of this machine when in operation, and Fig. 86 a side view of the frame, of which Messrs. Flory & Co., the manufacturers, send us the following description:

The rollers B and C^1 are 8 feet between the side-pieces. The roller B, forming the axle, is about 16 inches longer than the other. The wheels are 24 inches in diameter, 4 inches thick, made of pieces of 2-inch lumber. Front roller, C, 8 feet between side-pieces, 4 inches in diameter. Front wheels 10 inches in diameter, so set as to let the front roller and platform run within a few inches of the ground. Front wheels should be on movable axles, so as to raise or lower the machine. The platform is made of heavy ducking, endless, and revolves between the two rollers B and C^1. A head-block and key at each end is used to drive the roller C^1 up tight against the axle B. Side-pieces are made of scantling 2 by 6, 7 feet in front, 9 feet in rear of axle. Arms, G G, 2 by 2, so arranged as to raise or lower the cover, P. Cross-piece in front of roller C (diagram 2), set so close as to serve as a cleaner to the platform, also protects the platform from rocks, &c. A short apron is attached to this piece extending to the ground. (If necessary, a cleaner-strip may be placed immediately under roller C^1 (diagram 2).) W are canvas wings, extending forward and outward at an angle for the purpose of driving the grasshoppers in from either side, and, as the machine advances, they jump on to the movable platform and are carried into the rollers B and C^1 (diagram 2), and crushed. X X are iron rods hanging by ropes from the end of front cross-piece T. V V are wires extending from end of iron rods to cross-piece T. To the iron rods and wire the canvas sides are sewed. An apron of canvas hangs from the iron rods X X to sweep the ground. Over the top to the pieces C C a canvas cover is placed, tacked on, extending back to the cross-piece F. The sides are also closed up with canvas.

3. TRAPPING.—This can easily be accomplished, especially when the locusts are making their way from roads and hedges. The use of nets or seines, or long strips of muslin, calico, or similar materials, converging after the manner of quail-nets, have proved very satisfactory. By digging pits or holes three or four feet deep, and then staking the two wings so that they converge toward them, large numbers may be secured in this way after the dew is off the ground, or they may be headed off when marching in a given direction. Much good can be accomplished by changing the position of the trap while the locusts are yet small and congregate in isolated or particular patches.

Mr. A. N. Moyer, of Wyandotte, Kans., writes March 22, 1877:

A street or an alley will cause the locusts to vary a few points from their line of march. So, when approaching the banks of a river, before being able to fly, they will follow the banks seemingly in search of a bridge. At Independence, Mo., they came into town and were led to the public square, which is surrounded by a wall of dressed stone; several wagon-loads were removed in one day. Now, in aiming to capture and destroy them when they are on the march, suppose a portable fence lined with tin or some smooth material be used and placed in the form of a V with an opening at the apex and there a receptacle for them be placed or dug, I think immense quantities could be corralled in a day with very little labor. I have worked on that plan somewhat and know whereof I speak. Then, to assist them, let two men, holding opposite ends of a long piece of canvas or any light material which will bear a long stretch, surround and steadily run them into the portable pits.

A second fact concerning their habits can be utilized. At night, if cool, or at the approach of a shower, they run for shelter; trees always preferred. If on every acre or every five acres a cistern could be dug and some branches placed high above it or a tree placed as if in the center, immense quantities could be caught. I have seen many bushels massed at the foot of a large elm, between the cavities formed by its great roots; they were a writhing mass a foot in depth.

Mr. F. M. Dougan, of Mount Pleasant, Kans., has met with considerable success with the following mode of ditching:

Dig a pit 3 feet deep and from 2 to 7 feet wide, then make a ditch 2 or 3 feet broad and about 2 feet deep, running from the pit toward the point from which the locusts are making their appearance. To gather a broad army of insects, take a plow and run furrows diagonally from the ditch, which must afterward have all loose earth removed with spades. In this way the insects are brought together toward the ditch and finally into the pit.

Ditching and *trenching* properly come under this head; and both plans are very effectual in protecting crops against the inroads of traveling schools of the insects. They were found especially advantageous in much of the ravaged country in 1875, where there was little or no hay or straw to burn. They are the best available means when the crops are advanced, and when most of the other destructive methods so advisable early in the season can no longer be effectually used. Simple ditches, two feet wide and two feet deep, with perpendicular sides, offer effectual barriers to the young insects. They must, however, be kept in order, so that the sides next the fields to be protected are not allowed to wash out or become too hard. They may be kept friable by a brush or rake.

"The young locusts tumble into such a ditch and accumulate and die at the bottom in large quantities. In a few days the stench becomes great, and necessitates the covering up of the mass. In order to keep the main ditch open, therefore, it is best to dig pits or deeper side ditches at short intervals, in which the locusts will accumulate and may be buried. If a trench is made around a field about hatching-time, but few locusts will get into that field until they acquire wings, and by that time the principal danger is over, and the insects are fast disappearing. If any should hatch within the inclosure, they are easily driven into the ditches dug in different parts of the field. The direction of the apprehended approach of the insects being known from their hatching locality, ditching one or two sides next to such locality is generally sufficient, and when farmers join they can construct a long ditch which will protect many farms. * * * Where the soil is tenacious and water can be let into the ditches so as to cover the bottom, they may be made shallower and still be effectual. The width and depth of the ditch is important, and as experience differed somewhat, I have been at pains to get the experience of a large number of correspondents addressed by circular. Many have successfully used ditches 2 feet deep and 18 inches wide; a few have made them only 18 inches by 18 inches. Those who have used water found 12 inches by 15 inches sufficient, while the larger number used a ditch such as I have recommended, viz,

2 feet deep by 2 feet wide, with perpendicular sides. Having been the first to recommend proper ditching in this country, I have felt particular interest in its results, and have been in no small degree amused at the fault found with my recommendation by those who, through slovenly, made ditches or other causes, have not been successful in this mode of warfare. It is less effectual against the newly-hatched young, which more easily crawl up a perpendicular bank than the larger ones, and its efficacy will vary with the nature of the soil and other circumstances; for, in proportion as the soil is loose, and the ditches hence apt to fill up by the action of strong winds, or in proportion as strong winds carry the insects over, ditching will necessarily fail."

"Those who, from theory rather than from experience, are skeptical about the efficacy of ditching, urge that the locust, especially in the pupa state, can hop more than two feet. In truth, however, whether when traveling in a given direction of their own accord, or when being driven or disturbed, they very seldom leap that distance, as all who have had experience well know. That, on a pinch, the pupa can leap even farther, is true; but the fact remains that in practice *Caloptenus spretus* seldom does. So the Chinch-bug, though capable of flight, will yet tumble into a ditch by myriads rather than use its wings. Even the larger winged Acridia and Œdipodæ tumble into such a ditch, and seldom get out again. I would remark in this connection, also, that a ditch three feet wide, unless correspondingly deep, will be more apt to permit the insects to escape, when once in, than a narrower one. In hopping, the more perpendicular the direction the insects must take, the shorter will be the distance reached.

"The efficacy of the ditch depends not so much on the inability of the young locusts to jump or scale it, as on their tendency not to do so. In the bottom of the ditch they soon become demoralized, crippled, and enfeebled by constant effort, and the trampling and crowding upon one another."

From the numerous instances that have come to our knowledge, we give the following to illustrate the benefits derived from proper ditching: Just back of the fair-grounds at Kansas City, Mo., Mr. F. D. Adkins had about three acres in vegetables in 1875. The locusts hatched in large numbers all around the city, but were especially abundant in the immediate vicinity of this truck-garden, and seemed bent upon its destruction. Mr. Adkins, remembering his experience with the same plague in 1867, began active operations in ditching for their destruction in 1875; and though the country for miles around was laid waste, yet this little three-acre field was untouched—a perfect oasis in the desert, at once giving pleasure to the eye, and speaking eloquently of what may be accomplished by a little judgment and perseverance.

Of the experiences in 1877 as to the efficacy of ditches, the following are some of the more valuable:

Yours of June 27 was duly received, and, in answer, would say, that up to the present our "'hopper-ditches" have proved entirely successful, or, at least, to my full

satisfaction, to wit: We have probably not lost to exceed one acre out of seventy-five planted, including corn, wheat, rye, oats, and potatoes or vegetables, among which we had planted peas, beans, beets, lettuce, onions, squashes, melons, &c. Our 'hoppers have been gone now ten or more days, but we are in constant fear that they will drop down upon us every day, but if they do not we shall have a full crop, so far as 'hoppers are concerned.

Inclosed please find a rough pen-sketch of my farm and surrounding country, showing the water and 'hopper ditches, also the different crops on the place and those of my neighbors, L. J. Apply, A. J. Gillman, and W. D. Cole, who cut ditches around what little wheat they have left unharmed after they saw that my ditches were proving successful, and I am happy to state that they have likewise been as successful as myself, so far as they took advantage of the 'hoppers, but they did not commence until these had eaten in some distance from the edge of their grain; consequently they were compelled to cut through their grain to head them off.

I first had a ditch cut all around the outside of my place, commencing on the northwest corner and finishing on the southwest corner, at the slough; then I had ditches cut around the garden, truck-patch, and wheat, to protect those from the 'hoppers hatched on the farm. My ditches were from one and a half to two feet wide, and about as deep as wide, with perpendicular banks or sides, and two post-holes side by side across the bottom of the ditch (with seven-inch post-auger bits) two feet in depth, about once every rod, at first, and afterward, in places where large swarms or herds attacked us, as often, sometimes, as every four feet.

Up to the time of the development of the 'hoppers' wings a less number of pits or trap-holes will do, but after that time it is very necessary to have the sink-holes near together, as the 'hoppers will travel but a short distance in the bottom of the ditch before they will attempt to climb the sides unless precipitated into a pit-hole, consequently the sink-holes are the most important part of the warfare, the ditch acting as a kind of run-way to the trap or sink-holes. As to the cost of the ditch it must be born in mind that our land is a light sandy loam, and consequently very easy digging, and I was fortunate in hiring most of my laborers rather cheaply, from 75 cents to $1 per day and board, and the hands cut from 15 to 20 rods per day each, making an average of 17½ rods per day; but I think they were extra good laborers.

After the ditch was complete, and with sink-holes about one to every rod, I employed a good, responsible laborer for a month to keep the ditch in order and bore new sink-holes as often as the others were filled with 'hoppers, always putting some earth in the holes containing the 'hoppers, covering them to prevent their escape and the disagreeable odor from decomposition. And let me here remark that, while this last laborer made an average of two hundred and thirty sink-holes per day, two feet deep, he was at times unable to furnish sink-holes as fast as they were filled with 'hoppers, so that every few days I was obliged to furnish an extra hand to assist in making sink-holes.

In regard to the number of bushels of 'hoppers caught, it is difficult to determine, as a part of the holes would be filled full, and others probably not more than three-fourths full. Each hole, if full, would contain at least half a bushel of 'hoppers, if alive, and I think more rather than less.

The hatching-grounds were all about us, the ground being literally filled with eggs almost everywhere around us, as well as on the farm, 20 acres of which was breaking. I am quite certain that all the 'hoppers hatched on my farm were in the ditch before they were two weeks old, respectively; and had all of my neighbors commenced ditching as thoroughly as we did and as early in the season (I commenced about the middle of April), I am quite sure we would have had a good crop all about the country and with not more than half the labor that it was to us after the ditch was dug; besides we would have had but very few, if any, 'hoppers to take wings and fly away.

I have demonstrated to my mind that a ditch cut around 160 acres of land before hatching time, supplied with only a limited number of sink-holes, will catch all the 'hoppers hatched on said land, besides many from the outside, before they are more

than two weeks old, respectively. 'Hoppers are very uneasy when young, and almost constantly on the move when the weather is fair, and will, as a consequence, reach the ditch at some point soon after they are hatched out. We had but little or no trouble to take care of the 'hoppers until after they were more than half grown and had traveled two or three miles and had collected in large droves; then they came in such numbers that it was sometimes difficult to take care of them. But if my neighbors had provided ditches but a small number of those would have ever reached us.

The number of rods of 'hopper-ditch cut on my farm is between 650 and 700 rods, at a cost not to exceed $1 per acre of the entire farm of 120 acres.

Through low, wet places, where ditches are impracticable, stock-boards can be set up edgewise and use common fence-boards for caps (thus: T), breaking the joints of the stock-boards with the center of the fence-boards, to prevent the stock-boards from falling over.

There were times after the weather became warm when, in passing along the ditch, it would remind one of a hive of honey-bees swarming, from the buzzing noise of the "bluebottle" flies, busy among the dead and dying 'hoppers in the sink-holes, and sometimes the stench was so great from decomposing 'hoppers that it was sickening to pass along to the windward of the ditch.—[J. C. Curryer, Saint James, Minn., July 12, 1877.

But people are everywhere coming back to the realization of the fact that the ditch is the best thing of all. At Clearwater they began at least a week earlier than at Monticello, and all turned to ditching with a prospect of saving half a crop.—[Mr. Allen Whitman, June 16, 1877.

Ditching is the most effectual way of fighting the young, but is too expensive in a new country where many poor men have to fight single-handed.—[J. G. McGrue, Audubon, Becker County, Minn., November 5, 1877.

Farmers living at Brushy Bend dug a ditch over half a mile long, on the north side of a farm. At the bottom of the trench they made holes about five feet apart, making about four hundred and eighty holes in all. Each of these holes will hold about a bushel, and the 'hoppers traveling south from the sand-ridges will fill them quite full in one day. This would seem incredible, but nevertheless that one ditch is destroying about four hundred and eighty bushels of 'hoppers per day.—[*Nebraska Eagle.*

They can be fought, and fought successfully. Pans with kerosene or coal-tar may be economically used. But ditching is the thing; yes, the very thing. This season, in this county, hundreds of bushels have been destroyed by this method; whole farms, reaching hundreds of acres, have been perfectly protected. One of our citizens has taken over one hundred bushels, and this at a time when the insects were not one-third grown.—[A. H. Gleason, Little Sioux, Iowa, June, 1877.

From what I have seen, I believe that on the smooth, open prairie, where ditching is properly done, it is one of the best means of protection against the young 'hoppers.—[J. I. Salter, Saint Cloud, Minn., June, 1877.

Ditching has been resorted to and proved satisfactory. Nature of soil, sandy loam; depth of ditch, eighteen inches; width of ditch, two feet.—[Thomas Nixon, Argyle, Sumner County, Kans., June 5, 1877.

Protection by barriers.—Where ditches are not easily made, and where lumber is plentiful, a board fence two feet high and with 3-inch batten nailed to top on side from which the locusts are coming, the edge of it smeared with coal-tar, will answer as an effectual barrier, and prove useful to protect fields or gardens.

Coal-oil.—The use of coal-oil and coal-tar may best be considered in this connection, as both substances are employed in various ways for trapping and destroying the insects. As we shall presently see, in con-

sidering the different available destructive agents, coal-oil is the very best and cheapest that can be used against the locusts. It may be used in any of its cruder forms, and various contrivances have been employed to facilitate its practical application. The main idea embodied in these contrivances is that of a shallow receptacle of any convenient size (varying from about 3 feet square to about 8 or 10 by 2 or 3 feet), provided with high back and sides, either mounted upon wheels or runners, or carried (by means of suitable handles or supporting-rods) by hand. If the "pan" is larger than, say, 3 feet square, it is provided with transverse partitions which serve to prevent any slopping of the contents (in case water and oil are used), when the device is subjected to any sudden irregular motion, such as tipping, or in case of a wheeled pan, when it passes over uneven ground. The wheeled pan is pushed like a wheelbarrow; the hand-worked pan is carried by long handles at its ends. On pushing or carrying, as the case may be, these pans, supplied with oil, over the infested fields, and manipulating the shafts or handles so as to elevate or depress the front edge of the pan as may be desired, the locusts are startled from their places and spring into the tar or oil, when they are either entangled by the tar and die slowly, or, coming in contact with the more active portion of the oil expire almost immediately. In Colorado they use it to good advantage on the water in their irrigating-ditches, and it may be used anywhere in pans or in saturated cloths, stretched on frames, drawn over the field. The method of using it on the irrigating-ditches in Colorado is thus reported by Prof. R. L. Packard: "It consists essentially in pouring, or, better, dropping coal-tar or coal-oil on the running water with which the irrigating ditches are supplied. The method of supplying these ditches with oil is very simple. It is only necessary to sprinkle a few drops of coal-tar on the stream, when the oils contained in the tar are diffused over the surface of the water, and coming in contact with the insects (no matter how many), cause their speedy death. The toxic power of coal-oil upon the insects is very remarkable; a single drop of it floating on the water is capable of causing the death of a large number of insects. A simple and ingenious mode of keeping up a constant supply of the tar to a ditch I saw exemplified upon the farm of Mr. Arnett. A three-quart can is perforated on the side close to the bottom, a chip loosely fitting the aperture is inserted therein, and the can is then immersed (by a weight if necessary) in the ditch. Three quarts or less of tar, trickling out drop by drop from this slight vent, are sufficient to keep a great length of ditch supplied with coal-oil for thirty-six hours. The precise extent of ditch which may thus be rendered toxic to the locusts cannot, of course, be exactly stated. It is in fact quite indefinite, for the reason that the quantity of oil necessary to kill one of the insects is almost infinitesimal, and for the further reason that a single drop of oil will cover quite a large surface when dropped on water, so that taking these two facts together, it is easy to see that a very small quantity of tar or oil

will serve to guard by means of ditches a large tract of territory from the ravages of the young (unwinged) locusts."

The pans that were used in Kansas and Iowa, but principally in the former State, were of very simple construction and very effectual. We give the descriptions of them as they first appeared in Mr. Riley's *Locust Plague in the United States:*

"A good and cheap pan is made of ordinary sheet-iron, 8 feet long, 11 inches wide at the bottom, and turned up a foot high at the back and an inch high at the front. A runner at each end, extending some distance behind, and a cord attached to each front corner, complete the pan, at a cost of about $1.50. (Fig. 87.)

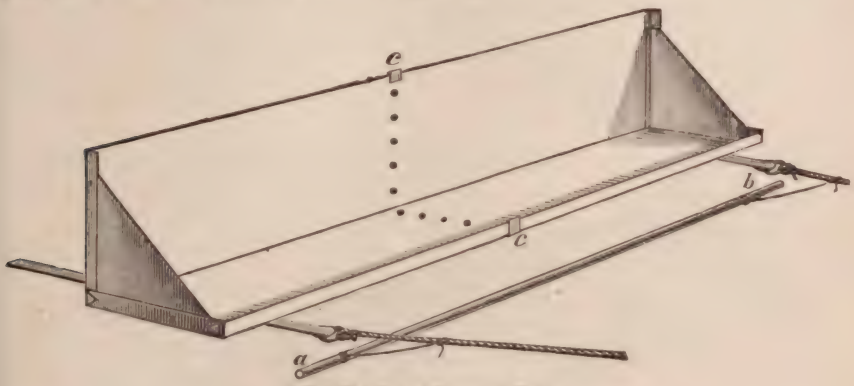

FIG. 87.—SMALL COAL-OIL PAN.

"We have known from seven to ten bushels of young locusts caught with one such pan in an afternoon. It is easily pulled by two boys, and by running several together in a row, one boy to each outer rope, and one to each contiguous pair, the best work is performed with the least labor. Longer pans, to be drawn by horses, should have transverse partitions (Fig. 88) to avoid spilling the liquid; also more runners.

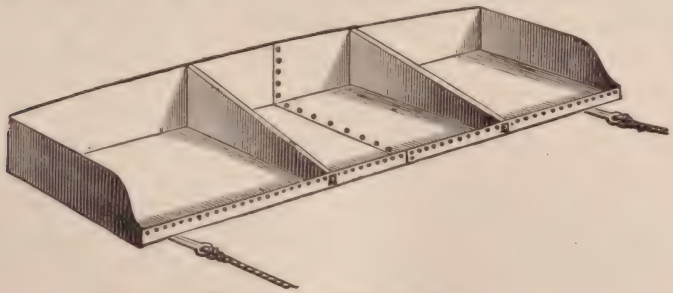

FIG. 88.—LARGE COAL-OIL PAN.

The oil may be used alone so as to just cover the bottom, or on the surface of water, and the insects strained through a wire ladle. When the insects are very small, one may economize in kerosene by lining the pan with saturated cloth; but this becomes less efficient afterward, and frames of cloth saturated with oil do not equal the pans. Where oil has

been scarce, some persons have substituted concentrated lye, but when used strong enough to kill, it costs about as much as the oil. The oil-pans can be used only when the crops to be protected are small.

"Small pans for oil, attached to an obliquing pole or handle, do excellent service in gardens."

Mr. A. A. Price, of Rutland, Humboldt County, Iowa, sends the Commission the following description of a coal-oil pan to be drawn on runners, and which was used with much success in Northwestern Iowa:

Take a common board from 12 to 16 feet in length for the foundation or bed-piece. Make a tin trough 4 inches deep, 6 inches wide, and as long as required. Divide the trough into partitions by means of strips of tin, so that each partition is a foot long, thus avoiding the spilling of oil. Back of this place a strip of tin 16 inches wide and as long as the trough. The back must be firmly secured by braces running down to the front edge of the board. Under all this place three wooden runners 3 feet long and shod with iron for the trough to ride on. Fill the pan half full of water and then add a small quantity of kerosene, sufficient to cover the water. A horse may be hitched to the machine by fastening a rope to the outside runners. * * * The lightness of the machine will allow its being used on any crops. * * * * *

A machine of this sort was patented by Mr. Lorenzo B. Canfield, of Syracuse, Nebr. (Patent No. 187,509, dated February 20, 1877). The following description and figures will serve to illustrate his pan more fully. Fig. 89 represents a perspective view; Fig. 90 a longitudinal sectional view on the line *x x* in the preceding.

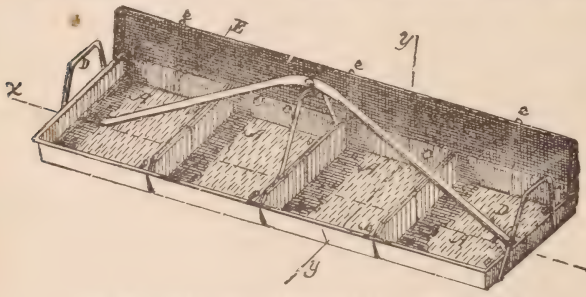

FIG. 89.—THE CANFIELD LOCUST PAN: Perspective view.

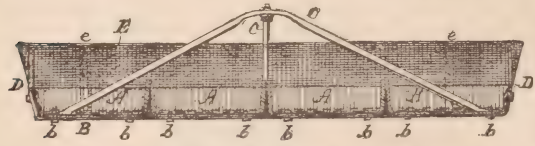

Fig. 90.—CANFIELD PAN: Longitudinal section.

Referring to the parts by letters, letters A represent the pans, made of zinc, tin, or any light suitable material, and of any suitable size and depth adapted to the method of propulsion. For carrying by hand I have found about 2 to 3 feet long, 2 feet wide, and 3 to 4 inches deep a very good size. The sides of the pans may all be perpendicular to the bottom, except the front side, which should be a little inclined, as shown at Figs. 1 and 3, to facilitate passing over grass, oats, wheat, and vegetation similar in size. The pans A are placed in a row, close to each other, and united by bottom straps B, to which they are secured by rivets *b*.

C is a truss, its ends secured to the extreme ends and bottom of the two outer pans A, and its central part secured upon the upper end of a king-post, *c*. D D are handles, one at each end of the series of pans. E is an upwardly-extended back for the pans, and is formed by simply extending the backs of the pans themselves upward, or by attaching a light cloth back to standards *c*.

It will be evident that the series of pans may be extended to any desired length, or that a single pan may be used short enough to sustain its own weight, or made longer and braced, as described, and divided transversely by walls into compartments, which will prevent the oil running all to one end of the device when such end is lower than the other.

In operation the device is carried by the handles D, with the pans near to the ground, and as it is advanced the insects jump up and are received in the advancing pan, or, striking the back E, fall into the petroleum, of which there is one-half inch or more in depth in the pans, where they die, or, jumping therefrom, die on the ground.

This pan was sold in the West at an exorbitant price, $4 being charged for royalty. Wherever we had an opportunity we advised farmers not to use it, but to construct others such as we have already described, and every bit as good, at far less expense. The principle cannot be patented, for since 1875 similar coal-oil pans, virtual outgrowths of the canvas frames originally employed for the same purpose, have been "known and used" in Colorado. This fact is sufficient in law to defeat any patent right based upon any application for a patent subsequent to such knowledge and use.

The essential features in all the contrivances are, in fact, 1. A platform that runs on the ground, on runners or wheels; 2. A canopy at right angles with it; 3. A reservoir at the junction to contain the liquid.

Another pan, of which we give a sketch (Fig. 91), was made by Mr. James

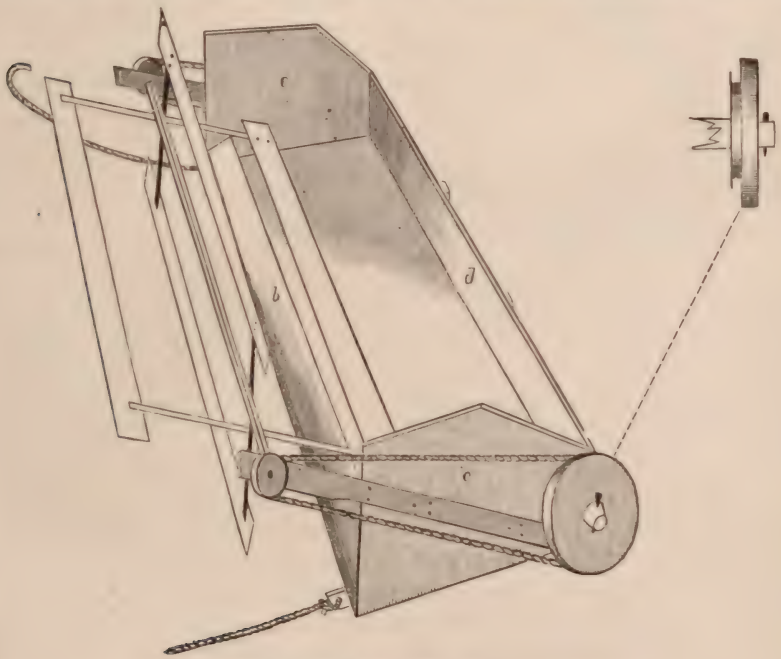

FIG. 91.—THE ADAMS LOCUST-PAN.

Adams of Abilene, Kans. It is 10 feet long, 2 feet wide; back (*a*) 1 foot high; front (*b*) about 2 inches high at the inner edge; ends (*c*) 2 feet high. The front is made of a board 6 inches wide, leaning inward at an angle of about 45°. A cloth screen is placed on the back part, which prevents the reel from knocking the locusts back over the pan.

The whole is made of pine, and costs $8 or $10. The pan is painted within with asphaltum paint, which renders it impervious to water or oil. The pan rests in front upon runners, to which ropes are attached for drawing, and on wheels behind which carry belts to turn the reel. The reel revolves just in front of the pan, causing the locusts to hop,

and then knocking them into the pan. A brush of cloth is sometimes fastened to one arm of the reel to brush into the pan any locusts that may be on the front piece. Several of these pans were used about Abilene, and did good work.

A contrivance shown in Fig. 92 was constructed by President John A. Anderson for use on the Agricultural College farm at Manhattan, Kans. The following description is taken from the *Industrialist:*

Yesterday afternoon we had the following cheap machine built in a couple of hours, which thus far promises to do all the work of either of the oil-machines: Three pieces of fence-board, 4 feet long and 3 or 4 feet apart, serve as sled-runners. To the front ends is nailed a fence-board 15 or more feet long. To this, and over the runners, three pieces of slats, each 4 feet long, are attached by a leather hinge; and inch-and-a-half holes through the back end of these slats receive light standards, the lower ends of which are fastened to the back ends of the runners by a leather hinge. Peg-holes in the upper half of the standards enable you to place the slats at any desirable angle. On the back ends of these slats is nailed a strip 15 feet long, parallel with the fence-board and 3 feet from it; and to these is tacked coarse muslin 15 feet in length, which forms an apron or movable screen that can be set at any angle. To the front ends of the outside runners a long piece of fence-wire was attached, and a mule was hitched to the wire, much to the disgust of the mule. A boy can pull the light machine, but mules pull longer than boys do.

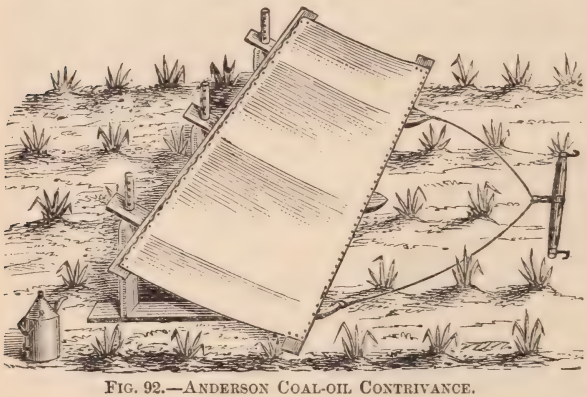

FIG. 92.—ANDERSON COAL-OIL CONTRIVANCE.

On trial it worked to a charm; and this morning the ground gone over shows several dead 'hoppers to the square foot, notwithstanding the fact that they had quickly jumped off the apron. It should be used against the wind, and promises to be very effective. Any man can make the above in two hours, and it is worth trying.

It was found to do very good service, killing the young locusts in considerable numbers. The oil did not evaporate so rapidly as was anticipated. One thorough saturation was sufficient for fifteen or twenty minutes, when a little more could be added. If the machine be hauled against the wind, nearly all the locusts which hop will touch the oiled canvas. They generally take several hops upon the canvas before leaving it, thus insuring a thorough saturation with the oil. After hopping from the apron they can take two or three hops upon the ground, then lose all power in their hind legs, stretching them straight out behind, and finally, in one or two minutes after being "oiled," they are dead.

The *Weekly Rocky Mountain News* of May 16, 1877, contained the following notice and description of another contrivance:

Mr. Ben Long brought into town yesterday about a half bushel of grasshoppers, weighing 35 pounds, caught in four hours, on half an acre of ground, two and a half miles northeast of Boulder, with his new machine. The machine is composed of two troughs, each 5 feet long, and joined V-shape, the angle being toward the body of the machine. It takes up about 7 feet in width. The troughs are 5 inches wide, an inch high, filled mostly with water and covered with kerosene. Behind the trough is

a wire screen, set in such a shape, that if the 'hoppers jump against it, they must fall into the trough. It runs so close to the ground that few, if any, of the pests escape below it.

Mr. C. L. Watrous, of Des Moines, Iowa, suggests a contrivance of this sort, with the addition of a wing on either side of the trough, extending forward and outward, so as to catch more locusts, that may be upon the ground. He further states that this is about the only means that was employed there for killing them.

Mr. G. V. Swearingen, of Sidney, Iowa, under date of June 14, 1877, states:

The cheapest, and to my mind the most successful, device or machine is muslin or ducking, 10 feet long, about 2½ feet wide, fastened to strips at each edge, stretched at ends and in center or more places with other strips; a piece, 18 inches wide at rear, supported by upright strips. Saturate with coal-oil, and have a boy at each end carrying it slowly over the ground.

The locusts, in hopping, light on the saturated surface, and are killed by the coal-oil, which appears to me to be the most destructive to them of anything yet tried.

Coal-tar.—This may be used with most of the contrivances just described for the use of kerosene, and while not equal to the simple kerosene pan for speed in trapping and destroying, is yet very useful, especially in the neighborhood of gas-works where the coal-tar can be obtained at nominal cost. It also permits the use of the simplest kind of pan. Enough tar is spread over whatever receptacle may be used to cover well the bottom, and when this becomes sufficiently matted with the young locusts so as no longer to destroy the new comers, another coating is added, and so on until it becomes necessary to remove the whole mass, when it is shoveled from the pan and burned; or, what is far preferable, wherever there are wet ditches, it may be thrown into these, when the oil contained in it, spreading over the surface of the water, destroys such locusts as may jump into or be driven into such ditches. Where the tar is scarce, as a matter of economy it will pay to melt the accumulated mass in iron vessels. By skimming off the dead locusts that rise to the surface, and thinning the residuum with a little coal-oil, it may be used again.

The Hon. A. B. Robbins, State senator from Willmar, Minn., deserves credit for having, by an opportune letter in the Saint Paul *Pioneer Press and Tribune* of May 17, successfully drawn the attention of the people of his State to the advantageous use of coal-tar. It had been applied in one way or another in previous years, not only in Kansas and Colorado, but even Minnesota.

The New Ulm (Minn.) *Herald* of May 28, 1875, had urged its use spread upon sheets of building-paper, and the same recommendation was referred to in full in a report to the geological and natural history survey of Minnesota for 1876. The *Farmers' Union*, of Minneapolis, under date of August 8, 1876, in a letter from Greeley, Colo., had described the use of the same material spread over stout canvas fastened

to a frame, to be dragged over the ground. It was referred to in the following words in Mr. Riley's eighth annual report for 1875:

Mr. Rufus Clark, of Denver, uses a piece of oil-cloth 9 to 12 feet long and 6 feet wide. One side and each end are secured to light wooden strips by common carpet-tacks, and the corners strengthened by braces. The oil-cloth is smeared with coal-tar, purchased at the Denver gas-works for $7.50 per barrel, and the trap is dragged over the ground by two men, a cord about 10 feet long being fastened to the front corners for that purpose. The entire expense of the "trap" is about $3.50, and as it is light and easily handled, will be found serviceable on small as well as large farms. Zinc, instead of oil-cloth, has also been used for the same purpose.

Finally, the same use of it in much the same words was recommended on page 51 of the Report of the Conference of Governors held in Omaha in the autumn of 1876, ten thousand copies of which report were published; while it was further recommended in our first Bulletin, distributed in April, 1877. It is somewhat surprising, therefore, that its use should have proved such a novelty, though the fact finds explanation, perhaps, in the simple form of pan recommended by Senator Robbins, and the commendable enterprise which Governor Pillsbury displayed in aiding the farmers to obtain material. The coal-tar plan, when so forcibly brought to notice, gained favor at once and soon created quite a furore. The following extracts will show what was thought of it, the extent to which it was used, and the effective manner in which Governor Pillsbury assisted the farmers of his State:

When, after a brief effort to exterminate the insects, there seemed to be a common inclination to abandon the struggle in despair, a contrivance of sheet-iron and coal-tar was resorted to, with such results as promised a successful issue of a vigorous warfare upon the pests. Concurrent reports of the successful working of this device continued to reach me from various portions of the afflicted region, and, after much inquiry and a personal inspection of its operation on the theater of the worst devastation, I deemed it possessed of so much efficiency as to warrant an effort to induce its comprehensive use. I thought this justified both by the practical results to be expected and by the moral effect of a vigorous struggle in self-defense. The emergency not admitting of time for definite arrangements respecting the costs involved, I telegraphed the several counties concerned, offering to furnish immediate supplies, upon an understanding of future reimbursement by them. This offer was promptly accepted, and all available supplies for material having been secured at wholesale sources, a vigorous war of extermination was maintained simultaneously in twenty-nine counties of the State. In three or four of these, comprising the dense center of the destroying swarms, the expedient proved unavailing. In all the rest, and especially wherever protective ditches had been first constructed, a fair degree of success attended these efforts, a vast amount of grain and other products having been by this means unquestionably rescued from destruction. In the prosecution of this enterprise there were employed about 56,000 pounds of sheet-iron and 3,000 barrels of coal-tar, which required a total expenditure of about $10,350. Toward this I applied the unexpended half of the five thousand which the last legislature placed at my disposal for relief purposes, and obtained the remainder upon my personal credit. The counties have made reimbursements as promised to the amount of $3,200, leaving about $4,700 yet to be provided for. As commendable efforts of this character, which aim at self-protection, without hope of reward other than that dictated by enlightened policy, are especially deserving of encouragement, I recommend that the State assume the whole expense of the movement, refund the sums which have been paid, and release from their obligations the counties which are in arrears.—[From Governor Pillsbury's annual message for 1877.

Meeker County, Minnesota, summoned the county commissioners and determined to send for 250 barrels of coal-tar and 1,000 sheets of iron. Other counties took similar action, and for a time it was impossible to supply the material fast enough. When tar was wanting, kerosene, molasses, ashes or sand moistened with kerosene, ashes and water, soft soap, or flour and water were used; the latter, when well filled with young locusts, was fed to the hogs. Tar was shipped over the different lines free of freight charge, and the State provided a supply of 1,000 barrels to be distributed wherever it was needed.—[Mr. Whitman.

Since Thursday morning there has been shipped from this city to points in Minnesota, over the Chicago, Milwaukee and Saint Paul Railroad, over 2,000 barrels of coal-tar and 20 tons of sheet-iron, consigned mostly to the governor of that State. The articles have been sold by Chicago merchants at cost price, while the railroad company has taxed the shippers a merely nominal figure for hauling the freight, as they are the parties who, next to the farmers, expect to be most largely benefited in the end. The coal-tar will be used for the extermination of the young grasshoppers, and the sheet-iron is required for the construction of a machine for the effective utilization of the tar. Thousands of these machines will be built in Minnesota before the end of next week. The machine is simple in its construction. A strip of sheet-iron 12 or 15 feet long is bent up on one edge sufficiently to admit of its passing over lumps of earth. Other strips, from 4 to 6 inches wide, are riveted to the other edge and at each end, forming a kind of scoop. (This is a "scoop" on the other grasshoppers.) A wire is attached to each front corner of the scoop by which it can be drawn over the ground. A chain or rope is fastened so that it will drag upon the ground about 18 inches in advance of the machine. This will scare up the grasshoppers. The inside of the scoop is thickly plastered with coal-tar, and the machine is dragged across the field against the wind. Millions of 'hoppers will stick to the tar. When the scoop gets full the driver can either scrape off the insects in a heap and burn them or blaze them against the bottom of the machine.—[*Chicago Times.*

Saturday, May 19, our community was much excited over the working of "Robbins's 'hopperdozer," sent from Willmar, on trial. It has taken like wild-fire, and I venture to say that to-day (May 23) there are over 1,000 of these contrivances in operation, capturing from two to five bushels per day per pan. It consists of sheet-iron pan 7 to 9 feet long, back and sides turned up 6 inches, and front edge about three-fourths of an inch, drawn by rope attached to wire rings 1½ feet from either end; bottom and sides thickly smeared with coal-tar, costing 10 cents per gallon by barrel; pan drawn over the ground very slowly. The efficiency of this simple contrivance is wonderful. One gallon tar is good for a bushel of 'hoppers, when rightly used. Some use two pans, that behind taking what the front passes over. Danilson and Cedar Mills are about the same, if not worse, than this town. Everbody begins to realize the situation.—[J. M. Howard, Litchfield, Minn., May 23, 1877.

Testimony is pouring in from all sides as to the wonderful success of that cheap little contrivance of sheet-iron and coal-tar invented by Mr. Robbins in sweeping up and destroying the grasshoppers. The people of Meeker County are so delighted and encourged by the success of the experiments which demonstrate the ease with which, by means of this economical instrument, they can conquer the grasshoppers, that the people of the whole county are organizing to sweep the county clear of the plague. They have appointed a committee to take immediate steps to place these machines or the sheet-iron and coal-tar of which they are constructed, within the reach of every farmer in the county, and the county authorities have taken the responsibility of devoting to that purpose a small sum of about $1,500 in the county treasury. So great a demand, however, had sprung up for these materials, in consequence of the demand for the Robbins's 'hopperdozer, that it was beginning to be difficult to procure them, and the committee therefore came down to Minneapolis and Saint Paul to enlist the efforts of the governor, and he was so well satisfied of the efficacy of the sheet-iron and tar contrivance that he at once proceeded to make arrangements to furnish at cost all the coal-

tar and sheet-iron which may be needed, not only in Meeker County, but throughout the State. He telegraphed to Milwaukee and Chicago to secure all the coal-tar that can be had there, and if this supply is not sufficient, arrangements will be promptly made to secure it from other sources. Similar orders were telegraphed for an indefinite supply of sheet-iron, and these materials will now be furnished by the governor either at Minneapolis or Saint Paul at the rate of $3 per barrel for coal-tar and 4½ cents per pound for sheet-iron, and the railroads will carry it free to any point on their lines. About 250 barrels of coal-tar have been ordered for Meeker County alone, and some five tons of sheet-iron, and it is thought they will require perhaps twice this when they get the whole people to work. The success of the Robbins's 'hopperdozer has had a wonderful effect, the committee say, in lifting the cloud of despondency which had settled on the brows of the farmers. The discovery that by the expenditure of one or two dollars in smearing a piece or two of sheet-iron with some coal-tar, and dragging it over the ground, they can easily exterminate the enemy that had seemed so formidable, and that seven cents' worth of tar will swallow up a bushel of grasshoppers, has put them all in splendid spirits, and they are now going to work with a will, one and all, to clean out the pest. * * * We are authorized to announce that Governor Pillsbury has made arrangements now deemed adequate to supply any amount of sheet-iron and coal-tar at the bare cost of the materials, and now that it has been demonstrated that the 'hopper can be destroyed and the crops of every farmer saved by this cheap instrument, the public-spirited citizens and the official authorities of every county should at once—to-day, before night—set on foot a movement for enlisting the whole body of farmers in the prompt and immediate application of this efficacious remedy for the locust plague.—[Saint Paul *Pioneer Press and Tribune.*

The simple pan so extensively employed, and which was known as the Robbins 'hopperdozer,[92] is shown in the accompanying illustration (Fig. 93), the general plan being that of the ordinary road-scraper. Its sim-

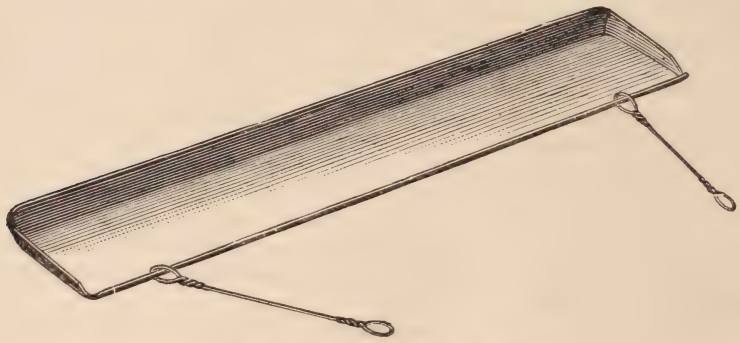

FIG. 93.—THE ROBBINS COAL-TAR PAN.

plicity and durability account for its general use. It was usually drawn by hand, though several pans were frequently bound together and drawn by horses; while, in some instances, certain improvements in the way of mounting on wheels, so as to permit its being pushed from behind, were also adopted. We saw some with a wire screen or cover hinged to the back, so that the insects might be secured when the pan was not in motion; but the cover seemed superfluous. We also saw lime and kerosene mixed so as to form a mortar substituted for the coal-tar.

[92] A word that came into very general use last year among farmers for coal-oil and coal-tar machines, and which doubtless takes its origin from doze, in reference to the toxic effect of the coal-tar on the locusts.

Another device was used in Colorado last summer, but is more complicated. It consisted of a skeleton cylinder of wood frame-work covered with canvas, the interior of which was to be coated with coal tar. The ends were opened and fans were arranged there, so constructed as to throw the locusts into the interior of the cylinder, where they would become entangled in the tar and be poisoned by it. The machine runs on wheels whose axle is the axis of the cylinder.

A correspondent of *The Kansas Farmer*, in the issue of June 6, 1877, describes the following contrivance:

I yesterday put together a machine which I do not propose to patent. It is constructed as follows: I had riveted together two sheets of stove-pipe iron, each 2 by 7 feet, making a surface of 4 by 14 feet. I rolled up the back side about 18 inches high, and held it to its place by nailing to it rounded inch boards. I turned up the front a trifle, and nailed to it a narrow strip of siding to stiffen the machine under the bottom, well back, so that it will balance. I fixed a three-eighths round iron for an axle, and fastened it by driving a staple over it near the ends and into the boards, end pieces. The wheels should be 16 inches in diameter, made of inch boards, three thicknesses nailed together, so that the grain of the wood will cross. I push my machine with a handle made of half-inch iron, a piece 12 feet long, the ends flattened, and fastened to the end board with screws, the rod bent up and made the proper shape, so as to come about to the bottom of a man's vest when operating the "dozer." I cover the surface with tar (common), which will burn and is poison to the 'hopper. The machine tilts over the axle and can be made to scrape the ground or raised to pass over grain or obstructions. The "dozer" is a perfect success, gathers the 'hoppers almost as clean as a reaper will cut grain; none get away. One week's work and four gallons of pitch tar will clean the worst 'hoppered 160-acre farm in Minnesota. At one priming with tar yesterday my man caught in about an hour a half bushel, estimated to make ten bushels when grown.

4. CATCHING OR BAGGING.—"There are innumerable mechanical contrivances for this purpose. The cheapest and most satisfactory are those intended to bag the insects. A frame two feet high and of varying length, according as it is to be drawn by men or horses, with a bag of sheeting tapering behind and ending in a small bag or tube, say one foot in diameter and two or three feet long, with a fine wire door at the end to admit the light and permit the dumping of the insects, will do admirable work. The insects gravitate toward the wire screen, and when the secondary bag is full they may be emptied into a pit dug for the purpose. These bagging-machines will prove most serviceable when grain is too high for the kerosene pans, just described, and they will be rendered more effectual by having runners at distances of about every two feet, extending a foot or so in front of the mouth, so as to more thoroughly disturb the insects, and prevent them from getting underneath; also by having wings of vertical teeth, so as to increase the scope with as little resistance to the wind as possible."

Two important facts should always be borne in mind in using these bagging-machines: 1st, that they should always be drawn, as far as possible, against the wind, if this be stirring; 2d, that in proportion as the insects and the grain are advanced in growth, and the former be-

come predisposed to roost, in that proportion the machines will prove more serviceable at night.

We constructed a machine last summer embodying the features already mentioned, and it answered the purpose very well indeed. We reproduce the following account from the *Scientific American:*

Professor Riley, of the Entomological Commission, perfected last summer a grasshopper machine, which seems to be just the thing. It is intended to do away with all extra material, like coal-oil, which in the long run is expensive, and to work at all seasons, whether the insects are just hatching or full grown. It is not patented, nor does the Professor intend to patent it, unless it should be found necessary to prevent others from doing so. It was worked at Manhattan, Kans., and gave great satisfaction, and was described in the *Industrialist*, the organ of the Kansas State Agricultural College, as follows: (See Fig. 94.)

The mechanical department has constructed a new locust exterminator for Professor Riley. The machine operates upon the bagging principle. It is, briefly, a large canvas bag stretched upon a light but strong frame, and placed upon runners, which extend with curved tips a little in front of the mouth. The canvas is stretched upon the inside of the frame, thus making the bag smooth and even within. This bag has a mouth (A) ten feet long and two feet high, and converges backward to a small box or frame, one foot square, with a slide cut-off (D). This box forms the mouth to a secondary bag (B), two and a half feet long and one foot in diameter, which ends in a second frame having two short runners below it. There is a sliding door (E) of wire gauze in the end frame, and the secondary bag is strengthened by a couple of strips of leather connecting the two small frames. The machine is made to "take more land" by means of two right-angled triangular wings (C), about six feet long, that hinge to the upright ends of the large frame, in such manner that the rectangle joins the upper corner of the frame. From the lower side of this wing are suspended a number of teeth, or beaters, which, swinging loosely, drive the locusts inward. The machine is handled by means of two ropes hitched to the outer runners or to the outer and lower side of the mouth of the frame.

On smooth ground the machine can be easily hauled by two men, but where the grass is tall and thick it pulls harder. The locusts, on hopping into the machine, soon reach the small back portion, enter the small bag, and are attracted to the rear end by the light which enters by the gauze door. When a sufficient number are thus captured the machine is stopped, the cut-off is slid down in front of the secondary bag, a hole is dug behind the machine, the bag tipped into it, and the insects buried. A strip of leather closes the slit through which the cut-off slips, and the main bag is made of dark cloth, while the secondary bag is white, so as by contrast to attract more thoroughly the locusts.

The advantages of this machine are that it requires no additional expense to run it, as for oil, tar, &c. It will catch the winged locust as well as the young, if operated on cool mornings and evenings, and is adapted to almost all conditions of growing grain. The machine can be made for about $10, and perhaps less.

In practice we found it best to draw the machine by hitching to the runners, and to brace the wings at desired angles, according to the strength of the wind, by means of two iron rods, as in the illustration.

A net which has done good service, made by Maj. J. G. Thompson, of Garden City, Minn., is made as follows:

Two pieces of common batten about 16 feet long were used as frame-work for the mouth of the net, one for the bottom and one for the top. From the end of the bottom piece a wooden shoe of the same material ran back about 6 feet to steady the trap and serve as a runner. To the rear end of this shoe a similar piece was fastened by a hinge, and ran forward and was fastened to the top piece of the frame, so that the mouth of the trap would open and shut like a jaw. To hold the mouth open, two short, upright posts were fastened to the top piece by a hinge, and rested upright upon the bed-piece. The net itself was made of cotton cloth for the bottom, and the top was made of mosquito-netting. The mouth of the net extended 16 feet from one side of the trap to the other, and the net ran back about 6 feet to a point with a hole at the end to let out the insects collected. A boy ten years old can draw one end of this net, and by the use of it Major Thompson saved one piece of wheat.

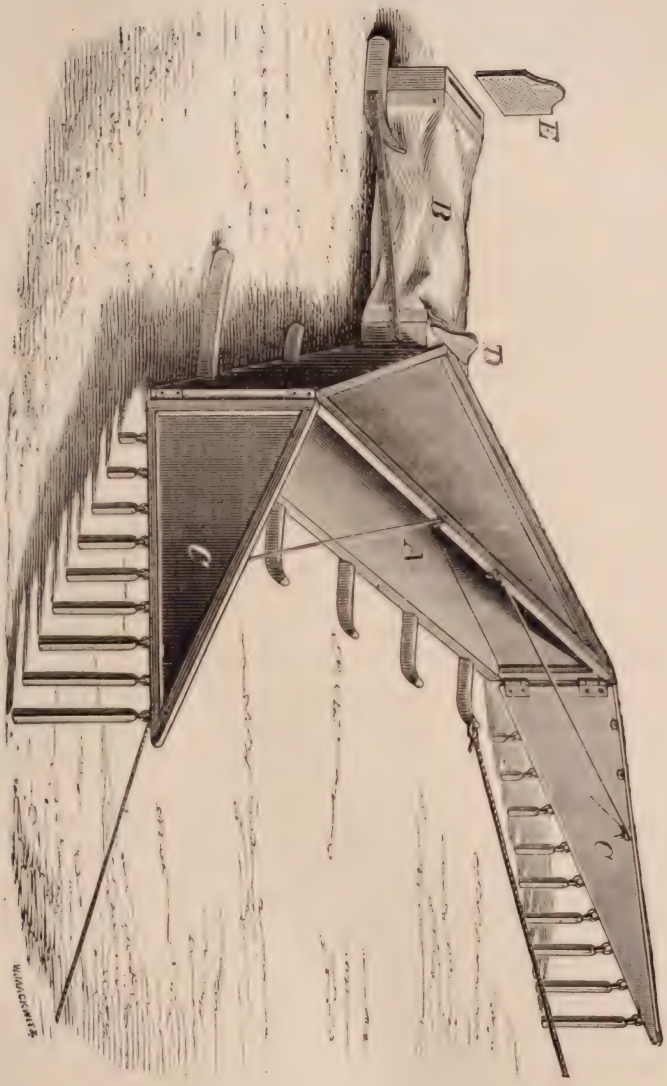

FIG. 94.—THE RILEY LOCUST-CATCHER.

Mr. J. C. Elliot, of Sheldon, Iowa, thus describes a machine of his own devising that was much liked in his section:

Take a strip of fine lumber 1 inch thick, 2 inches wide, and 10 or 12 feet long; about 18 inches from each end mortise in a strip about 2 feet long of the same material as your main piece; run a strong wire from one end of the main piece over the ends of the two upright pieces and fasten to the opposite ends of the main strip, forming the frame-work to the mouth of your dozer. The wire should be permanently fastened to the top ends of the upright piece to form a brace to keep them always in place. Place the long strip of lumber on the ground so that the standards stand perpendicular; take two widths of strong cotton cloth the length of your main strip, sew them together so you will have double width, tack one side of the cloth to the long wood strip; this forms the bottom. Take of mosquito-bar enough to form a top to the net, fastening one side to the wire running over the top of the standards; put in such gores of cotton cloth at the ends as you may need to form a complete sack of the cotton cloth and mosquito-bar. A good plan to facilitate taking out the 'hoppers after caught is to let the back part of the net run to a point in the center, and leave a small opening, which can be fastened with a string while at work, and unloosened to empty out the 'hoppers. The object of the mosquito-bar is to allow the wind to pass through and keep the 'hoppers in the net.

A very successful method of catching pupæ was used by Mr. Lowe and Mr. Hall, farmers, in McLeod County, Minn. It is simply equivalent to a wagon-body with one side removed, to be drawn over the grain after dark. The locusts roosting on the grain fall into it, simply lie there and become entangled in a mass, and may be easily shoveled into a hole. Mr. Hall thinks he caught 800 bushels in the latter part of June; Mr. Lowe, 400.

While in Iowa we inspected one of the following machines, which was not in working order, however, at the time. Nor was it much used, even in the locality where invented. It is patented by Mr. George S. Wilson, of Malvern, and Mr. John Rhode, of Tabor, Iowa (patent No. 192,553, dated June 26, 1877), and is described below. (Fig. 95.)

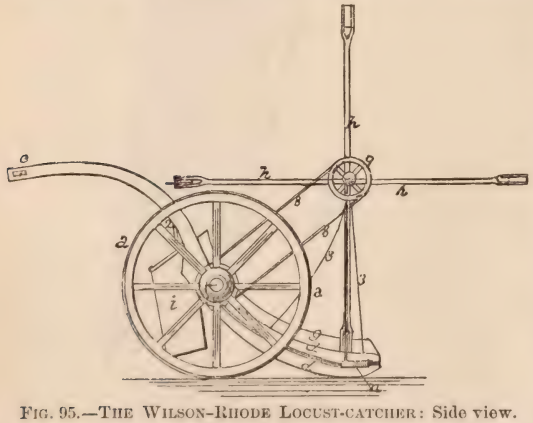

FIG. 95.—THE WILSON-RHODE LOCUST-CATCHER: Side view.

a a represent two driving wheels, upon which the machine is propelled about by a person or persons pushing from behind on the handle *c*. The frame consists, preferably, at each end of the two curved timbers *d*, as shown, between which is clamped a curved sheet-metal plate, *e*, which forms the floor of the machine. Secured to the inside edge of the top timber, at each end, is a curved plate, *g*, which forms a flange along each end of the machine, in order to prevent the insects from being swept or jumping from the floor.

To the rear edge of the floor is secured a box or receptacle, *i*, as long as the floor is wide, into which the insects are swept whole by the reel *h*. The cover of this box does not quite reach to the forward edge, thus leaving the space 1, through which the insects fall into the box. The upper end of the lid is turned backward a considerable distance, so as to form the flange 2, thereby preventing the insects from being swept back past the floor and opening 1 upon the ground behind.

Extending across the front edge of the machine is a board or bar, *n*, sharp at its front edge, and the ends of which project beyond each side of the frame, and serve as a support for one of the three braces or standards 3, upon the tops of which the reel is

journaled, and operated by the belt or chain 8 over the pulleys 9. The axles 5, upon which the wheels *a* are placed, have their inner ends made U-shaped, so as to straddle over the edges of the timbers *d*, to which they are secured by set-screws. By thus forming these spindles a heavy axle is dispensed with, and the wheels can be adjusted back and forth, so as to regulate the distance the edge of the floor shall travel from the ground.

The sweeps of the reel may consist either of plain strips of wood, or the strips may have sheets of rubber or any other suitable material clamped in between, or secured to them, as shown.

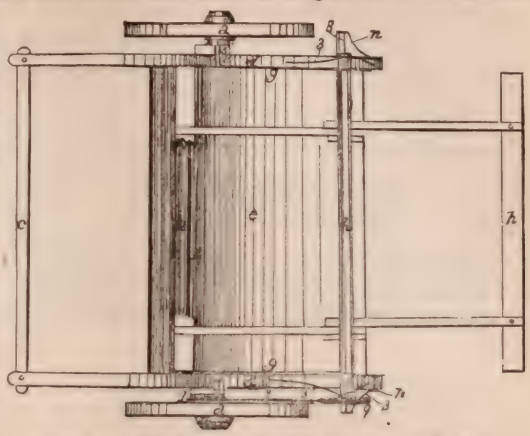

FIG. 96.—WILSON-RHODE LOCUST-CATCHER: Top view.

Mr. Samuel Godard, of Marysville, Mo., invented a machine for catching locusts (patent No. 191,421, dated May 29, 1877), of which we give the accompanying illustrations.

FIG. 97 is a plan view of the invention. Fig. 98 is a vertical section of the same, and Fig. 99 represents an end view of the revolving frame.

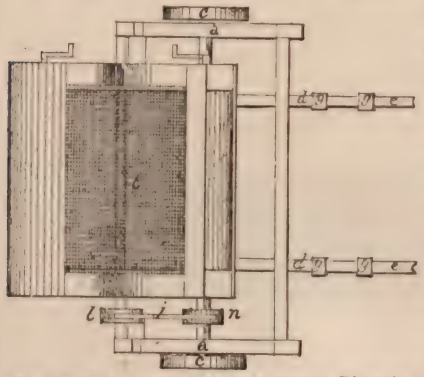

FIG. 97.—THE GODARD LOCUST-CATCHER: Plan view.

a represents a suitable rectangular frame, which is mounted upon the two wheels *c*, and provided with the two handles *d*, so that the whole machine may be pushed before a man, like a wheelbarrow. Where the machine is too large to be pushed by a man, the shafts *e* may be fastened upon the top of the handles by means of bands or loops *g*, substantially as shown, or of any other form, and then a horse be used for moving the machine about over the ground.

Mounted upon the top of the frame are the two brace-standards *h*, and journaled upon these standards is the revolving, wire-covered frame *i*, of the form shown, and which is made to revolve by a belt, *j*, that passes over the pulley *l* on the end of the shaft on which the frame revolves, and down around the pulley *n*, fastened to the axle of one of the driving-wheels. The frame *i* has two openings, *o*, one in each end, that extends the whole length of the frame; and inside of the frame, to each opening, there is a hinged door, *r*, which is held open by its crank while the machine is in operation, and then closed as soon as the 'hoppers are caught, so that they cannot escape. In one or both ends of the frame there are made openings or doors, through which the captured 'hoppers can be removed from the frame to be destroyed.

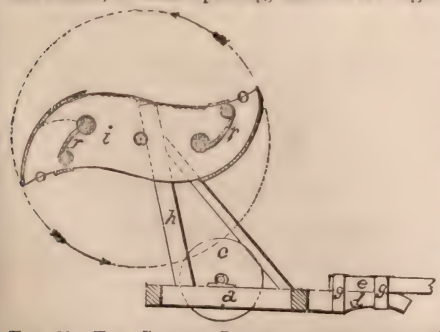

FIG. 98.—THE GODARD LOCUST-CATCHER: Vertical section.

This machine is to be pushed over the ground, and, as the 'hoppers rise in swarms before its approach, the revolving frame, with its openings at each end, flies around and gathers them in. After they are once in they can never escape the way they got in.

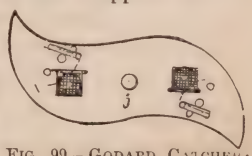

FIG. 99.—GODARD CATCHER: End view of frame.

A machine somewhat like the above was invented by Mr. Finley E. Benson, of Walnut, Iowa (patent No. 184,223, dated November 14, 1876). Fig. 100 represents a plain view of the machine, and Fig. 101 a vertical section of the same. The following is a more detailed description:

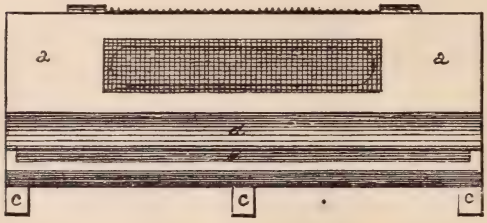

FIG. 100.—THE BENSON LOCUST-CATCHER: Plan view.

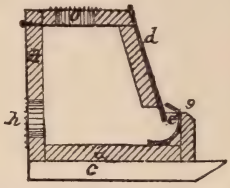

FIG. 101.—BENSON CATCHER: Vertical section.

a represents a long, narrow box or cage, which may either run upon the runners *c* or small wheels, as preferred. A portion of the front of this box is removed, as shown, and the inclined side covered with a sheet of tin, or other suitable substance, *d*, upon which the insects light, and then slide down, through the slit *e*, into the box. In order to prevent them from hopping out again, a guard, *g*, is made to extend horizontally over this opening in the front of the box, toward the inclined surface *d*, leaving just enough space between them to let the insect in, but not out again. In the rear side of the box *a* is made a light or long opening, *h*, which is covered over with wire-gauze, so as to light the interior of the box, and thus cause the insects to fly toward it, away from the slit. The top of the box is provided with a hinged cover, *i*, through which is made a similar light, *o*, for the same purpose, and so that hot water or steam can be forced into the box to kill all the insects caught.

The box is drawn or forced forward over the ground, and, as the insects light on the incline *d*, the motion of the machine shakes them down into the box through the slit *e*, where they are killed, and then emptied out through the cover

The machine invented by Mr. Dexter H. Hutchins, of Algona, Iowa (patent No. 187,012, dated February 6, 1877), differs from all the others in having attached a contrivance for killing the insects by means of sulphur fumes.

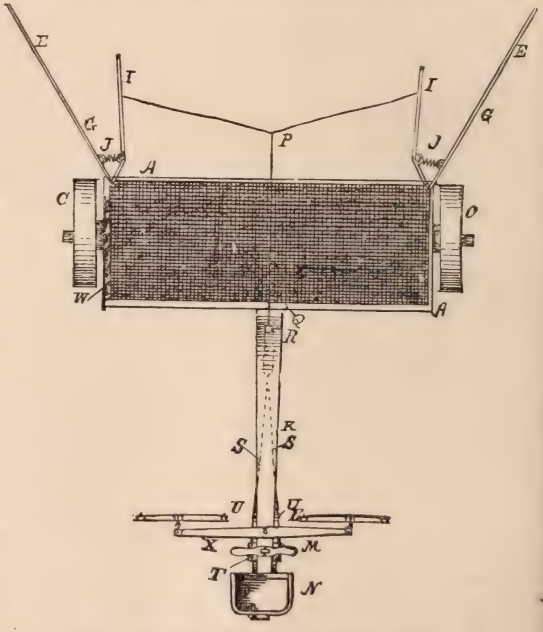

FIG. 102.—THE HUTCHINS LOCUST-CATCHER.

Fig. 102 is a top view, and Fig. 103 shows a sectional view.

The following description and letters refer to the accompanying drawings:

The frame A has a wooden bottom, B, and is mounted upon wheels C C. A drawer, D, is made in the front of the frame A, and opens to the front between the flies E E, attached to the frame F so as to project at an angle of about forty-five degrees out-

wardly from the frame F. The flies E E consist of wire frames G G, covered with canvas H, and are secured to the front uprights of the frame F, which is also of wire. Draw-flies I I are hinged to the front standards of the frame F, and are connected with the frames G G by spiral springs J J, which hold them open.

The frame F has its top ends and rear side covered with wire-gauze. A tongue, K, leads from the rear of the frame A, is supported at its rear end upon a caster-wheel, L, the shank of which penetrates the tongue K, and is provided with a foot-lever, M. A driver's seat, N, resting upon a spring, O, is secured to the tongue at its rear end, in a position to permit the driver to operate the foot-lever M. A cord, P, connects the draw-flies I I, and a cord, Q, attached to the cord P at its center, leads to a slot, R, in the tongue K, where it connects with two cords, S S'. The cords S S' are secured, one to each side of the frame T, in which the caster-wheel L has its bearings. Pins U U' are fixed in opposite sides of the wheel L near its periphery. Metallic slats V are pivoted longitudinally on the frame A, and are connected at one end by the rod W. A single-tree, X, is secured to the tongue K, slightly in front of the foot-lever M. The horses are harnessed to the machine with their heads facing the frame A.

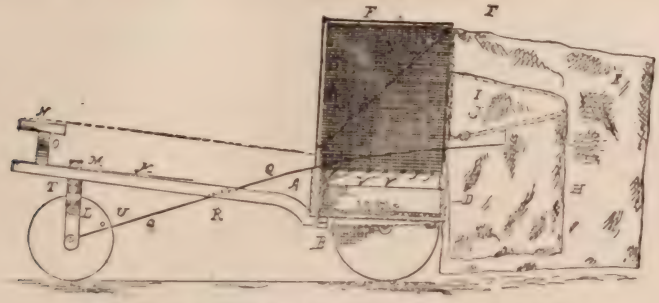

FIG. 103.—THE HUTCHINS LOCUST-CATCHER: Sectional view.

The operation of the invention is as follows:

The slats V are left partially open, and the machine driven over the infested field. The grasshoppers rise from the ground, and are drawn or driven into the frame F by the draw-flies I I, which are closed every revolution of the wheel L by the pins U or U' engaging with the cords S or S', as the case may be, both pins engaging when the wheel L is straight, but only one when it is turned to either side to guide the machine.

The pins U and U' are beveled on their rear sides, and the cords S and S' slip from said pins, when the pins are at the rear of the wheels and in line with the bearings of the same, and permit the draw-flies to open by the spiral springs J J.

The pins U U' and cords S S' may be dispensed with, if desired, and the cord Q may be extended to the driver's seat and there operated by hand.

When the space beneath the metal slats V in the frame A has been filled with the insects, the slats V should be closed, and the drawer D, previously supplied with sulphur, opened, the sulphur ignited, and the drawer closed. The fumes of the sulphur will destroy the grasshoppers, after which the machine may be cleaned and the operation repeated.

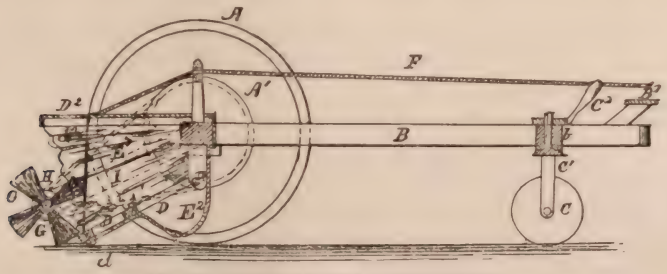

FIG. 104.—THE SYLVESTER LOCUST-CATCHER.

Another contrivance was invented by Mr. Benjamin Sylvester, of Saint Peter, Minn. (patent No. 188,760, dated March 27, 1877), of which

drawings are herewith given. The description refers to corresponding parts, and illustrates the mechanism and operation. (Fig. 104.)

A is a carrying-wheel, of which there are two, one being mounted upon each end of an axle, *a*. A frame-work consisting of two arms, B, connected by a girt, *b*, and carrying a driver's seat, B′, extends rearward from the axle *a*. The arms B are of such length and are placed at such distance apart that a horse can work between them and can propel the machine over the ground, being attached to a whiffletree which is pivoted to the girt *b*. C is a guiding or steering wheel, the shank C^1 of which is pivoted or journaled in girt *b* and provided with a hand-lever, C^2, arranged within convenient reach of the driver while riding in seat B′. At each end of the axle *a* there is a depending hanger, D^1, to which there is pivoted, at *c*, a vibrating arm, D, these two arms D D being connected by horizontal girts *d* and d^1. Immediately above the arms D there are two stationary arms, D^2, also connected by a horizontal girt, d^2. The arms D^2, girt d^2, and the axle *a* form a rectangular frame, over which is stretched a cover, E, the space between the arms D D^2 at each end of the trap being filled with a suitable flxible material, E^1. To the lower arms D and girts *d* d^1 is also attached a flexible covering, which hangs down loosely in rear of girt d^1 between that girt and the axle *a*, forming a bag or pouch, as indicated at E^2. This last-described part of the trap, consisting of the arms D D^2, their connecting-girts, and the covering E E^1 E^2, I usually denominate the cage. A cord, F, is connected with girt *d* or d^1, and passes over or through standard *f* and rearward to within reach of the driver. A revolving brush, G, is mounted in supporting-bars I. (Shown in dotted lines.) A belt, H, passes around a grooved wheel, A′, on one of the carrying-wheels A, and a corresponding pulley, G′, on the shaft of the brush G, thus causing the brush to rotate rapidly as the device moves forward over the ground and sweeps the grasshoppers or other insects into the cage.

By means of the cord F the height of the front part or edge of the apron or of the girt *d* from the grass or the grain or the ground may be indicated, and by a sudden upward jerk upon this cord any accumulation of grasshoppers on the apron between girts *d* d^1 may be readily delivered into the pouch or bag E^2.

When the device is made of suitable size it may be propelled by hand instead of horse-power.

The "Hero 'Hopper-catcher" constructed by John Carlen, Bernadotte, Nicollet County, Minnesota, is a simple bag with fan attachment, working somewhat on the same principle as the above.

Most of these patent contrivances are open to the objection of extra cost and complication without extra efficiency, and the simpler devices will always retain their deservedly greater popularity.

Mr. J. S. Belt, of the firm of Perkins & Belt, Saint Paul, Minn., constructed a simple sheet iron pan, intended to hold the locusts without the aid of coal-tar. The machine consists of a sheet-iron platform with a front sweep of 8 feet, the back of which is elevated 7 inches and the front $1\frac{3}{4}$ inches, in the shape of a runner. Over the platform is a contrivance that holds the locusts that hop upon the machine, and an effective cover prevents any from hopping over the grate. The implement is easily pulled by ropes, and, with a 3-foot wing on each side, it sweeps over 14 feet of field. Its capacity is three bushels, and it can be emptied in ten seconds.

The following letter from Mr. Pennock Pusey, private secretary to Governor Pillsbury, expresses the opinion of those fully competent to judge of its value:

"This will be handed you by Mr. J. E. Belt, who will exhibit a locust-machine, which strikes the governor and myself as the best thing yet invented. It is on the same simple principle as that of the sheet-iron and tar dozer, but dispenses wholly with the tar, and thus saves cost and delay. It was tested yesterday by Mr. Raney, of Le

Sueur County, who is probably the best practical authority in the State, and he heartily indorses it, as you will see by his letter. The inventor proposes to rush the manufacture of them extensively, and, all things considered, it seems worthy of notice."

We requested Mr. Whitman, our special assistant in Minnesota, to see the pan tried; he did so, and found it to work well, though it accomplishes nothing more than the tar-pan, and, on account of being more expensive at first cost, was not so generally used. The pan has, we believe, been patented, and can be built for $6.

Under the present head may be mentioned the method that has been and may be in future adopted, under peculiar and favorable circumstances, of driving the insects into streams and catching them, as they float down, in sacks; and, finally, the use of hand-nets, such as entomologists ordinarily use in collecting and catching winged insects. This method is strongly advocated by Gerstäcker, Körte, and other European writers, and may be employed with advantage in a small way with us where special crops are to be cleared that would be injured by other methods. A simple net, such as that herewith illustrated (Fig. 105) may be cheaply constructed by any tinsmith; the only material required being a piece of stout wire, a hollow tin tube in which to solder the two ends, and a piece of cotton or linen cloth, a wooden handle of any desired length being inserted in the non-soldered end of the tube.

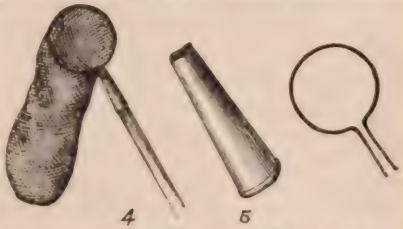

FIG. 105.—HAND NET.—*a*, complete; *b*, hollow handle; *c*, bent frame.

USE OF DESTRUCTIVE AGENTS.

We have never had much faith in the application to the plant or the insect of any chemical mixture, fluid, or powder, as a means of destroying the locusts: 1st, because nothing will more quickly or surely kill them than coal-oil; 2d, because of the impracticability of using any such application on the extensive scale that would be necessary. Yet as several parties sent us their various ingredients, patented or otherwise, with strong faith that in such they had discovered a locust panacea, we endeavored to give some of the more reasonable of them fair trial.

This we did the more willingly that it is possible to save special plants by some such means where the owners of the plants set a sufficiently high value upon them to warrant an amount of labor and expense that they would not think of bestowing on the ordinary crops of the field and garden. We, therefore, engaged Prof. R. L. Packard, of the Patent Office, and formerly chemist in the Department of Agriculture, Washington, D. C., to go to Colorado last June, while the insects were about two-thirds grown, and test various compositions and chemicals that had either been recommended by correspondents or which we ourselves desired to have tried. Among them we will enumerate the following:

The spraying of coal-oil variously diluted; the use of "Buhach" or Persian insect-powder (fresh powder, from plants raised in California, was sent us by G. N. Milco, of Stockton, Cal.); Veith's insect-fluid[93] (also sent by the manufacturers); sulpho-carbonates; bisulphide of carbon; hot alum water; naphthaline; quassia water in varying strength; strong tobacco water; uric or hippuric acid; sulphuric acid diluted with fifty times its weight of water; a few teaspoonfuls of saltpeter in a bucketful of water; salt water; vinegar; copperas water; cresylic soap.

Owing to unfavorable weather while in Colorado, Professor Packard failed to carry out experiments as completely as was desired; but we quote the following portions of his report, and shall refer in other chapters to other observations he made for the Commission:

The instrument in general use for destroying locusts is the coal-oil or coal-tar "pan," as it is called, many modifications of which are made to suit individual preferences or special emergencies.

As to chemical experiments, those chemicals only could be tried which would affect the insects by direct application to them, since, as remarked in a former letter, at the time of my visit the locusts were all young, very sluggish, and were not feeding. Consequently, of the hundred or more insecticides which have been patented in this country, most of which are to be used in protecting fruit-trees and other plants from the ravages of feeding insects, few could be tried. Of those remaining, aside from this class, the experiments of Dumas, conducted in France with a view to discover some agent destructive to the *Phylloxera*, have shown that the majority of such agents as are fatal to that insect are also destructive to the vines or detrimental to the soil, and, consequently, indirectly injurious to the vines. It would be useless here to enumerate the large number of natural and chemical compounds which the distinguished French chemist experimented with. Their number exceeds a hundred, and includes a large majority of those substances generally recognized as poisons. The report is to be found in "Annales de Chimie et de Physique," 5e série, tome vii, 1876. The general conclusion reached is that for attacking the *Phylloxera* the sulpho-carbonates and coal-tar are the best means to be employed. In dealing with locusts, however, the problem is an entirely different one from that to be solved in regard to the *Phylloxera*. In one case we have an active insect, continually moving from place to place above ground, while in the other a comparatively stationary insect, living under ground and remaining so as long as its food lasts, is to be dealt with. In the latter case the point was to find poisons which, giving off vapors during a sufficient length of time and acting in a confined space, would destroy the subterranean pest. In the former, however, the object has been to find some chemical which, acting by immediate contact with the actively moving locust, would cause its death, or which, scattered on the plants which it affects, would enter its system and so act as a poison. As before remarked, only the former of these objects could be kept in view, owing to the activity of the insects. No experiments, therefore, having in view the protection of plants could be made.

The following trials were made:

Buhach, or Persian insect-powder.—Several locusts immersed in this for from three-quarters of an hour to an hour, after being liberated from the bottle (they were completely immersed in the powder), brushed off the powder and moved off, although feebly. When the powder is blown upon them, as prescribed, they quickly brush it off, and disappear unharmed.

Veith's insect-fluid.—This proved to be very effective, killing locusts and plants with great celerity. Analysis shows it to be made up of oil of turpentine and a tincture (probably) of camomile. The oil of turpentine may well account for its deadly effects.

[93] This is manufactured in Philadelphia, and recommended for all sorts of insects, for many of which it could be of no possible use; and, like many other patent nostrums for all insect ills, it is very much of an imposition.

Sulpho-carbonate of potassium.—This salt was prepared from impure bisulphide of carbon, obtained in Denver (and containing naphtha), and an alcoholic saturated solution of hydrate of potassa. When sufficiently dilute, so as not to be injurious to plants, I think it is equally harmless to the insects. A strong solution (nearly saturated) causes the locusts to fall over and apparently kills them, but in fifteen minutes they revive, and in half an hour are able to hop off. A solution of 1 to 10 or 15 has to be repeatedly applied to have any apparent effect, and, as far as I could observe, this effect soon disappeared. The strong solution is sure and speedy death to plants, and yet does not appear to kill the insects, so that with a dilute solution, one sufficiently so not to hurt plants, no good effect can be had.

Naphthaline.—The impure specimens I was able to obtain at the gas-works in Denver, which contain many impurities, do not warrant me in reporting upon the effect of naphthaline as such. The effects I observed were far less satisfactory than those I obtained with coal-tar. Naphthaline, like bisulphide of carbon, can only work when kept in contact with the insects for some time. It gives off its vapors slowly, and is not, therefore, capable of successful application where locusts are concerned. I have watched a locust for three-quarters of an hour moving about over the impure naphthaline left in the oil-barrel by pouring out the oil (oil from coal-tar), whereas a single drop of the crude oil itself causes almost immediate death.

The above and Paris green are the principal substances experimented with, others being counted out, either for the reason that they are applicable only to the protection of plants against feeding insects which did not appear during my stay in Colorado; that their ineffectiveness is well known, or that chemical considerations (*e. g.* in the case of sulphuric acid) forbid their use, or demonstrate its impracticability.

In conclusion, I will say that I am a witness of the speedy action of coal-oil upon young locusts, an action which is certain and immediate. I have taken a straw, dipped in the crude oil distilled from coal-tar, shaken off the pendent drop, and touched the insects with the residue. Treated with this minute quantity they died in from eight to ten minutes. I have seen substantially the same effect with kerosene. As only a small quantity of oil need be employed it is perhaps unnecessary to point out the difference in price between kerosene and crude coal-tar oil, but the attention of farmers may usefully be drawn to the fact that such difference exists. They have, chemically speaking, certainly discovered the cheapest and most effective remedy against the ravages of the unwinged locusts. No known chemical is at once so deadly in its action and at the same time so cheap as "coal-oil." Its manipulation is simple and unattended with any danger which cannot be easily guarded against by a little care. This fact, together with its comparative cheapness and freedom from danger of adulteration, are the advantages it possesses which recommend its use as an active poison. This point is, I think, clearly settled.

The other questions of protection to plants, and of the chemical value of the immense quantities of locusts which annually die in the West, considered as fertilizers, as well as the further question (interesting in a scientific point of view) as to what is the chemical nature of those secretions of the mature locusts which are said to be deleterious to fowls and even to affect the human skin, must as yet remain unanswered.

The deadly effect on animal life of carbonic-acid gas is well known. In 1875 we used it from a Babcock extinguisher, and gave it a thorough trial under many different circumstances and conditions, but without any satisfactory results. It had very little effect upon them even when played upon them continuously and at short distance. They often became numbed by the force of the liquid, but invariably rallied again.

Paris green.—This, though it kills those insects which partake of it, is yet no protection to plants, because those which go off to die after

partaking are always followed by others which go through the same operation. A new mode of using it was earnestly advocated and strongly recommended by one of our correspondents in Texas, viz, by sprinkling it, mixed in the ordinary way with from 20 to 30 parts of flour, upon the ground. The locusts were found to be attracted by the whitish powder, and to gather about and feed upon it. We had it thoroughly tried with varying success, as the following experience indicates:

I have tried the experiment of Paris green and flour (1 part to 30), and do not find it a success. The young locusts did not seem *especially* attracted to it, *i. e.*, only from a distance of a few inches, and of those which went onto it, but few died. Mr. Payne states the same thing. I urged him to send a full statement of his experiment to you as I knew he would have an earlier and better opportunity to try it than I should.—[A. Whitman.

In experimenting with Paris green brought in contact with the insect, I captured several specimens and rubbed them in this compound, then set them at liberty and watched their movements for half an hour or more. In each case I saw the insect free itself by rubbing from the dry powder, and at the end of the time specified I saw no difference between insects so treated and their companions. I put one specimen, after thorough immersion and rubbing in Paris green, in a specimen-box, and opened the box two hours after. The insect was as lively as ever, and had freed itself, as far as I could see, from all traces of the chemical. Indeed, it is difficult, speaking from a chemical or physiological stand-point, to see why Paris green in dry powder should have any toxic effect when externally applied. Its poisonous effects are due to the copper and arsenic compound of which it consists, and which can only act as a poison when taken into the system in solution.

I made the following experiments with the same substance diffused in water: Insects were kept for some time (3 minutes) in water holding Paris green in suspension. On taking them out, they waited until they were dry, then brushed off the dry powder, and for half an hour (as long as I watched them), behaved in all respects like insects not experimented with. The reason, apparently, is that Paris green being insoluble in water under these circumstances, behaves like the dry powder; *i. e.*, the water evaporates, leaving the dry powder, which the insects proceed to wipe off.—[R. L. Packard.

In accordance with your request, I experimented with the Paris-green mixture. Used it on an inclosed square rod of wheat; also a rod of grass. Inclosure surrounded with boards a foot wide. One-half of each of these was treated by mixing Paris green with thirty-two times its weight of flour, and placing the mixture in cones upon the ground. Cones formed by taking the mixture between the thumb and two next fingers and compressing it, and placing the same upon the ground on about every 9 inches square. On the other half, the mixture was sprinkled upon the grass and wheat while it was damp with dew. The mixture was eaten by the hoppers; where it was placed in cones it was covered with the insects. Should say, that in 36 hours one-half the quantity had disappeared, and in 48 hours there were dead 'hoppers on the ground, but not in any satisfactory quantity.—[S. B. Coe, Morristown, Minn.

I have experimented with the arseniate of copper, as you desired, but with no practical effect. I mixed with dry flour first, but could find no dead locusts. I then mixed into a stiff dough and worked it into crumbs or pellets, and placed on the ground, made white by the dry preparation; result, one dead sparrow, and one cowbird, both great destroyers of the 'hoppers; but I could not find any dead 'hoppers, perhaps the birds ate them, but I am inclined to believe that their death came by eating the poisoned dough. I do not think the 'hoppers are attracted by white substances in any marked degree, for on spreading the brightest rye-straw alongside of old, rotten hay, that was very dark in color, I found them more numerous on the hay than on the straw. I have

tried spreading newspapers and dark, woolen rags side by side, and always find the majority of 'hoppers on the darker substance. This, I think, is on account of the warmth imparted being greater from the hay and rags than from the straw and paper. —[J. I. Salter, Saint Cloud, Minn.

One of our assistants in Kansas, Mr. G. Gaumer, found that, spread upon the ground, it attracted and destroyed a great many; but it is very clear that this mode of destroying the locust cannot compare with many of those we have already described. Its use against the young locusts is practically of little avail, because of the excessive numbers in which they generally occur, and because of the danger incident to the use of a poison on so loose and extensive a scale as would be necessary to make it effectual. Several other ingredients were strongly recommended by correspondents who, had they tried their own recommendations, would have discovered the uselessness of the same. One suggested alum-water; another, from Estillville, Va., expatiated on the merits of common salt, to be used with an ordinary drill; while still others found some protection from the copious use of ashes and of gypsum. Of all the different applications, however, intended to protect plants, we doubt whether anything is more effectual than the spraying of a mixture of kerosene and warm water, which will answer a very good purpose when the insects are not too numerous or ravenous.

THE PROTECTION OF FRUIT-TREES.

The best means of protecting fruit and shade trees deserves separate consideration. Where the trunks are smooth and perpendicular they may be protected by whitewashing. The lime crumbles under the feet of the insects as they attempt to climb, and prevents their getting up. By their persistent efforts, however, they gradually wear off the lime and reach a higher point each day, so that the whitewashing must be often repeated. Trees with short, rough trunks, or which lean, are not very well protected in this way. A strip of smooth, bright tin answers even better for the same purpose. A strip 3 or 4 inches wide brought around and tacked to a smooth tree will protect it, while on rougher trees a piece of old rope may first be tacked around the tree and the tin tacked to it, so as to leave a portion both above and below. Passages between the tin and rope or the rope and tree can then be blocked by filling the upper area between tin and tree with earth. The tin must be high enough from the ground to prevent the 'hoppers from jumping from the latter beyond it, and the trunk below the tin, where the insects collect, should be covered with some coal-tar or poisonous substances to prevent girdling. This is more especially necessary with small trees, and coal-tar will answer as such preventives.

One of the cheapest and simplest modes is to encircle the tree with cotton batting, in which the insects will entangle their feet and thus be more or less obstructed. Strips of paper covered with tar; stiff paper tied on so as to slope roof-fashion; strips of glazed wall-paper, and

thick coatings of soft soap, have been used with varying success; but no estoppel equals the bright tin. The others require constant watching and renewal, and in all cases coming under our observation some insects would get into the trees, so as to require the daily shaking of these morning and evening. This will sometimes have to be done, when the bulk of the insects have become fledged, even where tin is used, for a certain proportion of the insects will then fly into the trees. They do most damage during the night, and care should be had that the trees be unloaded of their voracious freight just before dark.

Mr. George Gibbs, of Holden, Mo., found that the whitewash was rendered still more effectual by adding one-half pint of turpentine to the pailful.

DESTRUCTION OF THE WINGED INSECTS.

"The complete destruction of the winged insects, when they swoop down upon a country in prodigious swarms, is impossible. Man is powerless before the mighty host. Special plants, or small tracts of vegetation may be saved by perseveringly driving the insects off, or keeping them off by means of smudges, as the locusts avoid smoke; or by rattling or tinkling noises constantly kept up. Long ropes perseveringly dragged over a grain-field have been used to good advantage."

Of the different contrivances already described for the destruction of the unfledged locusts, those intended for bagging and catching are the most effectual against the winged individuals, great numbers of which may be caught, especially at morn and eve, and late in the autumn. At such times many may also be crushed. These winged insects are more to be dreaded in the northern than in the southern portion of the locust area, for in this last the small grains are always harvested before the advent of the pests, and Indian corn is the staple that suffers. The experience of Minnesota and Dakota farmers teaches that the injury from the winged locusts is best avoided by growing such crops as will mature early. Reports were current last summer in Texas that farmers near Calvert had destroyed great quantities of the winged insects by fires lighted at night. We had on several occasions witnessed swarms of locusts driven before a prairie-fire, and our general experience of locust habits at night forbade belief in the reports, and we requested one of our correspondents to inquire into the matter, with the following result:

I took pains to trace up, while in Texas, the report that the *spretus* was attracted by a blaze. I found it, of course, baseless, though it had attained very respectable proportions.—[J. T. Moulton, jr.

Moderate success has been had with smudging as a means of warding off the winged swarms. The best method is to start a fire which burns with insufficient access of air, and which is made, if possible, of materials which, while burning, will give off, besides the dense smoke due to incomplete combustion, unoxidized products of distillation which in themselves are noxious (*e. g.*, buffalo-chips, straw, and coal-tar, &c.). The

smoke and fumes from such a fire will prevent the locusts from alighting and swerve them from their course. Mr. S. T. Kelsey succeeded in saving many of his young forest-trees in Kansas, in 1874, by perseveringly smudging and smoking them. He gives his experience in the following words, in the *Kansas Farmer*, August 26, 1874:

> At first we tried building fires on the ground, but it was not successful. The smoke would not go where we wanted it to. We then tried taking a bunch of hay, and holding it between sticks, set fire to it, and then, passing through the field on the windward side, held it so that the smoke would strike the grasshoppers. We would soon have a cloud of 'hoppers on the wing, and, by following it up, would, in a short time clear the field. We have thus far saved everything that was not destroyed when we commenced fighting them; and while I do not give this as an infallible remedy, not having tried it sufficiently, yet it does seem to me, from what I have seen of it, that one good active man who would attend right to it could protect a twenty-acre field or a large orchard. But to be successful one must attend strictly to business.

The great difficulty experienced in making the smudging successful is in the inconstancy of the winds, as a sudden change in wind direction may render much previous labor unavailing. Mr. W. D. Arnett, of Bear Creek, Colo., who has given a good deal of attention to the practical means to be employed against locusts, has endeavored to meet the difficulty by using a portable iron bucket as a fire receptacle. A large sheet-iron bucket is fitted with a perforated tube, arranged across its bottom, open at one end to admit air, and there provided with a valve to regulate the admission of air. A perforated cover, hinged to the bucket, and a handle to carry it by, complete the arrangement. Filled with some substance which burns imperfectly, such as buffalo-chips and a little coal-tar, and with the cover shut, an amount of air insufficient for complete combustion is admitted through the valved tube at the bottom, and the dense smoke comes out through the holes in the cover.

The burning of old bones has been tried, but found to be no more effective than other slow combustibles. The use of smoke will be effectual in proportion as farmers combine together and produce it simultaneously over extended areas.

THE EFFECT OF CONCUSSION.

Two modes of concussion have been proposed for the destruction of insects or their eggs; the first being terrestrial concussion, produced by means of exploding powder or other similar compounds in the ground; the second, by means of small fire-arms or cannon. No experiments have yet been made that give anything like satisfactory results. The vitality, whether of the locusts or their eggs, will hardly be affected by such means. We received a number of communications on the subject of concussion during the year, and will quote a few passages from the correspondence in illustration of the different views held. Mr. L. A. Hardee, of Honey Moon, Fla., who is most enthusiastic in urging this supposed means of destruction, writes: "I do not know how many

miles of the eggs of the 'hoppers can be destroyed by concussion of the ground, but it would not surprise me to know, when the experiment is tried, that 25 miles square would be destroyed by one explosion. Now, if one hundred pounds of gunpowder was buried, say three or four feet under ground, and this be ignited after a heavy rain, the concussion of the ground will destroy our small enemies that burrow in the ground for miles." Mr. P. A. Smith, of Lincoln, Nebr., writes.: "We know the firing of cannon over and the explosion of torpedoes in water will kill fish; that the explosion of shells in time of battle has often been known to paralyze and sometimes kill human beings." Mr. Robert W. Furnas, president of the Nebraska State Horticultural Society, writes that "burying powder below the surface for its combustion and destruction of insects is simply nonsense, and time and money wasted."

On the other hand, Mr. A. J Bell, of Mexico, Mo., says that during his residence at Ashland, Ky., he had a small vegetable garden, and noticed that his potato sprouts were covered with potato-beetles and locusts. "There happened to be a local option parade, and an old cannon was used in the vicinity of the garden, for firing salutes. Next morning he had occasion to visit the garden and found all the insects *dead*, both 'hoppers and potato-beetles."

While we have little faith in the efficacy of concussion as a means of destroying either locust-eggs or young locusts, we were nevertheless desirous of giving the matter trial, and commissioned Mr. Prosper A. Smith, of Lincoln, Nebr., to thoroughly experiment and report to us, requesting him to avail himself also of the assistance of Professor Aughey. It turned out that Professor Aughey had tested it with no satisfactory results in 1875, and after a few fruitless trials further experiments were abandoned as "too ridiculous," writes Professor Aughey, to warrant further outlay.

DIVERSIFIED AGRICULTURE.

In Chapter IV we have dwelt upon the advantages of diversified agriculture from the locust stand-point, and we desire here simply to lay stress on its importance, nay its necessity. "There is nothing surer than that the destitution in Western Missouri and Eastern Kansas, in 1874–'75, was fully as much owing to the previous ravages of the chinch-bug as to those of this locust. The Chinch-bug is an annual and increasing trouble; the locust only a periodical one. Now, the regions indicated are, agriculturally, the richest in those two States, and, for that matter, can scarcely be surpassed in the entire country. Consisting of high, rolling prairie, interspersed, as a rule, with an abundance of good timber, this area produces a very large amount of corn and stock. Of cultivated crops, corn is the staple, and, with a most generous soil, it has become the fashion to plant and cultivate little else, year after year, on the same ground. The corn-fields alternate more or less with pastures, and there is just enough small grain to breed and nourish the

first brood of chinch-bugs which pass into the corn at harvest time and which scatter over the country, by breeding and harboring in the corn-fields. Not to mention the different means to be employed in counteracting the ravages of this insect, a diversified agriculture is undoubtedly one of the most effectual. It must necessarily follow that the more extensively any given crop is cultivated to the exclusion of other crops the more will the peculiar insects which depredate upon it become unduly and injuriously abundant. The Chinch-bug is confined in its depredations to the grasses and cereals. Alternate your timothy, wheat, barley, corn, &c., upon which it flourishes, with any of the numerous crops on which it cannot flourish, and you very materially affect its power for harm. A crop of corn or wheat grown on a piece of land entirely free from chinch-bugs will not suffer to the same extent as a crop grown on land where the insects have been breeding and harboring. This fact is becoming partially recognized, and already hemp, flax, and castor-beans are to some extent cultivated in the States mentioned. But there are many other valuable root and forage plants that may yet be introduced and grown as field crops."

Governor Pillsbury, of Minnesota, has a few pertinent remarks on this subject in his last annual message. He says:

In my former messages I took occasion to urge upon farmers a greater diversification of their crops. The present tendency, I fear, is toward an aggravation rather than a correction of the evil referred to. Stimulated by recent heavy crops, land-hunters have a passion for immense tracts and great wheat-farms. While the cultivation of our idle lands is always desirable, this pursuit of a single branch of farming is to be lamented. And I fear that the expectations of great profits of many inexperienced persons who are drawn into the movement by excitement is doomed to disappointment. A wiser course is to look to many sources of profit rather than to one. There is no better country than ours for the raising of stock. Our wool, beef, butter, and cheese are unsurpassed. With the production of these, wheat-growing alternates admirably to the advantage to all the products. The continuous cultivation of a single crop must eventually exhaust the soil of the constituents for its profitable growth, while it is well known that the finest wheat crops were raised the past year on worn-out and abandoned grain-fields, which had been resuscitated by a couple of years' rest in grass. It seems almost culpable to import corn, hogs, beans, and other products which can be grown here to perfection.

What Governor Pillsbury says of Minnesota is equally true of a very large proportion of the country subject to locust injury. The advantage of growing more stock is especially obvious in some sections, not only as a means of best utilizing the surplus corn, but to avoid sweeping disaster; for when the locusts are so thick as to entirely sweep off cultivated crops, the wild prairie grass is seldom so badly affected that it will not support stock.

LEGISLATION.

"Too much stress cannot be laid on the advantage of co-operation and concert of action, and legislation both to induce and to oblige action is important. In every community there are those who persist in doing nothing to prevent locust injury. These indifferents frequently bring

ruin not only upon themselves, but upon more persevering neighbors, and any law will prove beneficial that will oblige every able-bodied man to work one or more days, either in the fall in destroying the eggs, or in the spring in killing the young insects, whenever the township trustees, at the request of a given number of citizens of the township, may call them to such work under special provisions similar to those of existing road laws."

In reference to bounty laws, the experience of Minnesota, where they were in force in some counties in 1875, is valuable, and the State commissioners did not hesitate to recommend the system after the county trials, imperfect as they were, and commenced as they were, in most cases, too late in the season. It was clearly shown that in one township $30,000 worth of crops was saved by an expenditure of $6,000. Nicollet County paid $25,053 for 25,053 bushels of locusts, but the price paid by other counties was higher; in fact, much too high. In 1877, as may be seen from Mr. Whitman's Report (App. I), the bounty system was less effective, and, indeed, proved more or less a failure. "As a means of defence," writes Mr. Whitman, "it would have proved useless in some cases and needless in others; as a matter of relief or reimbursement for injury it would have gone in a large measure to help those who are already repaid by an abundant harvest."

Governor Pillsbury, in his annual message for 1877, speaks of the Minnesota bounty-law, published further on, in the following rather severe terms:

These acts were approved by me with much reluctance, and not until I had strenuously but unavailingly endeavored to influence a correction in the act first named of what I deemed ill-advised provisions of a serious character. Prior to any movement for the practical operation of these laws, I received numerous statements from authoritative sources in all quarters of the infested regions, remonstrating against the appointment of measurers, as contemplated, on the ground that owing to the incalculable numbers of the insects the provision requiring the counties to pay all bounties in excess of the proposed State appropriation of $100,000 would virtually bankrupt the afflicted counties. I therefore deemed it proper to defer action for further knowledge and consideration. Finding upon calculation that an equal distribution of the available fund would afford to each inhabitant of the infested localities an average of but forty cents, a sum too trifling in itself to induce additional efforts for the extermination of the pests, I became convinced that the enforcement of the bounty-law would entail upon counties already impoverished by insect ravages a burden of debt which would prove more disastrous than the scourge it was intended to avert. I, therefore, against the wishes of a few localities, but in compliance with a vast preponderance of petitions from the people directly interested, declined to make the appointments requisite for the practical operation of the law. The decision was justified by the result, for, in the absence of that concerted defense against the insects by ditches and other protective means dictated by experience, all efforts induced by the proposed State and county expenditures combined, would certainly have been unavailing, especially where the destructive swarms were most dense and where protection was most needed from their ravages. The sum thus saved to the State remains intact, or rather the contemplated loan was not effected, the law in express terms specifying the exclusive object for which it was to be effected.

"A good law, once enacted and on the statute-book, may not be called into operation for many years, but would beyond all doubt serve an admirable purpose in the event of a locust invasion. The following are what we conceive should be the essential features of an efficient bounty-law: 1. *The bounty should be paid out of the State treasury; or it should be graded and borne equally, one-third by the local township, one-third by the county, and one-third by the State.* 2. *The bounty should be immediately available to those earning it.* 3. *The act should, so far as possible, tend to the destruction of the eggs.* 4. *After the eggs, the destruction of the newly-hatched locusts should be encouraged by the act.* A bushel of the newly-hatched insects will contain thirty or more times as many individuals as will a bushel of the pupæ, and, moreover, their destruction prevents the subsequent injury. It would be folly to pay 60 cents a bushel for them later in the season when they are nearly full-grown and have done most of the harm they are capable of doing. The price, therefore, should vary with the season; and while, in latitude 39°, 75 cents or $1 should be offered in March, the price should diminish to 50 cents in April, 25 cents in May, and 10 cents in June. As the dates of hatching vary with the latitude, so the law should vary in the matter of dates, according to the requirements of each particular State. In addition to the foregoing requirements of such an act, every precaution should be taken to prevent fraud and dishonesty in obtaining the money."

The laws obliging proper labor will prove more beneficial to a community than the bounty laws, and the labor is best performed, first in destroying the eggs in the fall, and next in destroying the young insects after the bulk of them have hatched out in the spring.

In the more thinly settled parts of the country laws may be more or less ineffectual, so far as the general destruction of the insects is concerned, though they will even there be one of the best means of relieving destitution; but in more thickly settled sections they will accomplish both results.

The following are the State laws respecting locusts that have been passed:

MISSOURI.

AN ACT to encourage the destruction of grasshoppers.

Be it enacted by the general assembly of the State of Missouri, as follows:

SECTION 1. Any person who shall gather, or cause to be gathered by any person in his employ, eggs of the Rocky Mountain locust or grasshopper, at any time after they are deposited in the earth in the autumn of any year, and before they are hatched the following spring, shall be entitled to a bounty of five dollars for each and every bushel of eggs thus gathered, or for any quantity less than one bushel, bounty at the same rate, to be paid, one-half by the State and one-half by the county in which they are gathered.

SEC. 2. Any person who shall gather, collect, and kill, or cause to be so collected and killed, young and unfledged grasshoppers in the month of March, shall be entitled to a bounty of one dollar for each bushel, and for the month of April fifty cents per bushel, and for the month of May, twenty-five cents per bushel, to be paid in the same manner as in the preceding section.

SEC. 3. Any person claiming bounty under this act, shall produce the eggs and grasshoppers thus gathered or killed, as the case may be, before the clerk of the county court in which such eggs or grasshoppers were gathered or killed, within ten days

thereafter, whereupon said clerk shall administer to such person the following oath or affirmation: You do solemnly swear (or affirm, as the case may be,) that the eggs (or grasshoppers, as the case may be,) produced by you, were taken and gathered by you, or by person or persons in your employ, or under your control, and within this county and State.

SEC. 4. The clerk shall forthwith destroy said eggs by burning the same and give to the person proving up the same, under his hand and seal, a certificate setting forth in a plain handwriting, without interlineation, the amount of eggs or grasshoppers produced and destroyed by him, and the name and residence of such person producing the same, which certificate shall be in the following form:

STATE OF MISSOURI,
County of ——:

This is to certify that ——, in the county of ——, A. B. did this day prove before me that he had gathered, or caused to be gathered, —— of eggs, —— grasshoppers, and is entitled to the sum of —— dollars, and —— cents.

Given under my hand and seal of my office this —— day of —— A. D. 18—.

—— ——, A. B.,
Clerk County Court.

Which certificate shall be received and taken by the collector of revenue of the county in which the same was given, and such collector shall be allowed pay out of the county and State treasury one-half from each.

SEC. 5. Such clerk shall keep a register of all such certificates given by him, in a book which he shall keep for that purpose, in which he shall note down every certificate granted by him, the number and amount, and to whom granted, and transmit a certified copy of such register, under the seal of the court, to the treasurer of the State, who shall not allow and pay any certificate which does not correspond with such register.

SEC. 6. Such clerk shall receive for his services as aforesaid one dollar for such certified copy of the register, and the regular fee for the certificate and seal, and ten cents for each certificate granted under this act, all to be paid out of the treasury of his county.

SEC. 7. As the object of this act is the rapid destruction of the locust the ensuing spring, it shall take effect and be in force from and after its passage.

Approved February 23, 1877.

This act is drawn up after the form recommended in Mr. Riley's eighth report, and reprinted in the Omaha pamphlet. Section 3, requiring persons claiming bounty to carry from all parts of the county the eggs or young insects collected, is defective, as those living near the county seat will have most advantage and inducement. It would be better to empower the township trustee or the street commissioner to receive and measure the eggs or young insects, and to issue certifiates setting forth the number of bushels destroyed, the certificates to be filed with the county clerk.

KANSAS.

AN ACT to provide for the destruction of grasshoppers, and to punish for violation of this act.

Be it enacted by the legislature of the State of Kansas:

SECTION 1. That the township trustees of the different townships, and the mayors of cities which are not included in any township of any county within this State, are hereby authorized, and it is made their duty when so requested in writing by fifteen of the legal voters of the township or city, to issue orders to the road-overseers of the different road-districts within their respective townships or cities, to warn out all able-bodied males between the ages of twelve and fifty years within their respective districts, for the purpose of destroying locusts or migratory insects.

SEC. 2. It shall be the duty of road-overseers, immediately after receiving said orders, to proceed at once to warn out all persons liable under section 1 of this act, giving notice of the time and place of meeting, and the tools to be used, and the kind of work expected to be performed, and all work shall be done and performed under the direction of the road-overseers.

SEC. 3. Any persons over eighteen years of age warned out as is provided in this act, may pay the road-overseer the sum of one dollar per day for the time so warned out,

and in case any persons shall fail to perform labor under this act or paying the sum of one dollar when so warned out, shall be adjudged guilty of a misdemeanor, and on conviction shall be fined the sum of three dollars for each day so failing or refusing, and the moneys so collected shall be expended by the road-overseers in the destruction of grasshoppers in their respective road-districts.

SEC. 4. For the purpose of carrying out the provisions of this act, the road-overseer is authorized to enter upon the premises of any person lying within the township where such order of the township trustee is in force, with a sufficient number of hands and teams to perform such labor as he may deem necessary for the public good.

SEC. 5. It shall be the duty of the secretary of the State Board of Agriculture, immediately after the passage of this act, to compile in circular form all information relating to the manner and means heretofore used for the extermination of grasshoppers, and send at least ten copies of the same to each township trustee in the State.

SEC. 6. This act shall take effect and be in force from and after its publication once in the Commonwealth.

Approved March 6, 1877.

AN ACT providing for a concert of action by senatorial districts for the destruction of grasshoppers.

Be it enacted by the legislature of the State of Kansas:

SECTION 1. That in any senatorial district in the State of Kansas where trouble is anticipated from the ravages of young grasshoppers in the year 1877, and any subsequent year thereafter, it shall be lawful for the counties in said senatorial district to co-operate together, in the way and manner herein provided, for the destruction of the same.

SEC. 2. The chairman of the board of county commissioners in the county having the largest number of inhabitants in a senatorial district, where two or more counties form said district, may notify the chairman of each of the boards of county commissioners of the remaining counties in said district, of the time and place when the chairmen of the several boards of commissioners of the respective counties forming said senatorial district shall hold a joint meeting.

SEC. 3. At such meeting two of their number shall be chosen to act as chairman and secretary, and the proceedings of the meeting shall be published in all the newspapers printed in the senatorial district.

SEC. 4. Said meeting shall designate the manner of procedure by road-overseers, and what day or days the young grasshoppers should be driven from the cultivated land on the unburnt prairie or places of destruction, and shall also designate on what day or days the grasshoppers shall be destroyed, by burning or otherwise, in said senatorial district, giving at least ten days' notice of the same by publishing in the newspapers of the said district.

SEC. 5. The board of commissioners of each county shall notify the road-overseers of said county of the time fixed upon by the joint meeting for the driving and burning, or destroying by other means, of the grasshoppers in the district; said notice to be given to said overseers as soon as practicable after the same shall have been determined by the joint meeting.

SEC. 6. Said road-overseers shall immediately notify the residents of his road-district of the time designated and the manner of procedure, in order to carry out the provisions of this act. He shall also specify what tools or implements will be required of each resident in performing the labor required of him; and such notice may be enforced the same as in the acts authorizing road-overseers to warn out the residents to perform road-labor; and a refusal shall subject such persons refusing to the same penalties as are provided by law in such cases.

SEC. 7. The road-overseers shall direct the manner of performing the labor, and have the supervision of the same, and shall keep a list of the names of those who shall perform labor, and shall certify the number of days' work performed by each, and shall place such certified list in the possession of the board of county commissioners of his county.

SEC. 8. It shall be lawful for two or more senatorial districts to co-opereate together under the provisions of this act, on a basis of action which they may agree upon.

SEC. 9. This act shall take effect and be in force from and after its publication in the Daily Commonwealth.

Approved March 7, 1877.

Both these acts look to compulsory work and concert of action, and in these respects are preferable to bounty acts, and will, without doubt, be productive of more good to the community at less expense to the State. The objects of the two acts were combined in one.

MINNESOTA.

AN ACT to provide for the destruction of grasshoppers and their eggs.

Be it enacted by the legislature of the State of Minnesota:

SECTION 1. There shall be paid by this State, out of any moneys in the treasury thereof not otherwise appropriated, to any person or persons living within any of the counties in said State afflicted by grasshoppers, the following bounties for catching and destroying of the same, and the destruction of their eggs:

SEC. 2. The sum of one dollar per bushel for grasshoppers caught previous to the 25th day of May next; the sum of fifty cents per bushel from the said 25th day of May to the 10th day of June; the sum of twenty-five cents per bushel from the said 10th day of June to the 1st day of July, and twenty cents per bushel from the said 1st day of July to the 1st day of October next.

SEC. 3. There shall also be paid in the same manner, the sum of fifty cents per gallon for any and all grasshopper eggs taken and destroyed by any person or persons.

SEC. 4. There shall be appointed by the governor a competent person in each township in the several counties so afflicted by grasshoppers, who shall be a resident of the township for which he shall be appointed, to receive, measure, and destroy the grasshoppers and their eggs delivered to him by any person or persons catching and taking the same, which said person so appointed shall take and subscribe an oath for the faithful discharge of his duties, which oath, together with the certificate of appointment, shall be filed in the office of the county auditor, and he shall receive as compensation for his services such sum as the county commissioner may determine, to be paid out of the funds of the county; and, in case of necessity, when he cannot perform the duties of his office, said measurer shall have authority and be empowered to appoint a suitable and competent person his assistant, which assistant shall be required to take and subscribe the same oath and be subject to the same penalties as the said measurer.

SEC. 5. The person receiving and measuring the grasshoppers and their eggs as aforesaid shall measure and immediately and effectually destroy the same, and keep an exact account of all the grasshoppers and their eggs received by him and the names of the persons delivering the same, and shall issue a certificate for the amount of grasshoppers and their eggs to the person delivering the same. And he shall, at the end of each week after commencing to receive and measure the same, and on the 2d day of June, on the 11th day of said month, on the 2d day of July, and on the 2d day of October next, make a report to the county auditor of all the grasshoppers and their eggs measured by him, the number of certificates issued, and the names of the persons to whom he issued the same; and the county auditor shall examine the same and file it in his office, which report shall be subject to public inspection; and the county auditor shall, at the end of each week after he shall have received the first of said reports, transmit a copy of the said reports to the governor, who shall, as soon as the sum hereby appropriated shall have been expended in the payment of said bounties, notify all persons interested therein of such fact by a publication of such notice in some newspaper printed and published at the city of Saint Paul, in said State of Minnesota, for three successive days.

SEC. 6. For a failure on the part of said measurer to perform any of his duties under this act, or for any mismeasurement of such grasshoppers and their eggs, he shall be deemed to be guilty of a misdemeanor, and be subject to pay a fine of not less than ten dollars nor more than one hundred dollars, or be imprisoned in the county jail for a term of not less than thirty nor more than ninety days, in a suit or proceeding to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law in other cases of misdemeanor.

SEC. 7. Upon the presentation of such certificate to the county auditor, he shall issue a certificate to the person entitled thereto for the amount due him (a form of which certificate shall be furnished by the State auditor), and shall make an order upon the State auditor for the amount thereof, and the State auditor shall draw his warrant upon the State treasurer for that amount in favor of the parties holding said certificates, which shall be paid by the State treasurer on presentation: *Provided*, That all certificates presented to the county auditor for payment shall be by him filed and preserved in his office, and he shall present such certificates to the board of county commissioners, who shall audit the same in the manner now provided by law for auditing accounts against counties; and no money shall be drawn from the State treasury until such certificates have been audited and allowed in the manner herein provided. And that no money shall be paid under the provisions of this act at any time prior to the fifteenth day of July, A. D. eighteen hundred and seventy-seven, and that the money hereby appropriated shall only apply to certificates duly made and filed with the auditor of state on or before said day; that at the time after the State auditor shall ascertain the total amount of all claims and certificates so filed, and if the same shall exceed in amount the sum of one hundred thousand dollars, then the said claims shall

be paid *pro rata*, and no other or greater amount than said sum of one hundred thousand dollars shall ever be paid under the provisions of this act: *And provided further*, That if the amount hereby appropriated is not sufficient to pay the certificates in full, the balance shall be paid by the counties respectively, according to the amount due on said certificates as issued by such county.

SEC. 8. Every male inhabitant of the several townships in the said afflicted counties, being above the age of twenty-one years and under the age of sixty years, excepting paupers, idiots, and lunatics, shall be assessed by the board of supervisors of said township to work one day in each week in said township, during the period hereinbefore mentioned for the paying of bounties, for the purpose of catching and destroying grasshoppers and their eggs, for five weeks from the time said grasshoppers shall become large enough to be taken; and the amount of work to be so assessed shall not exceed five days in all.

SEC. 9. The supervisors aforesaid shall make a list of the names of all persons against whom said tax shall have been assessed, and place in a column opposite each name on said list the amount of labor assessed against such person, and shall direct the town clerk to make a certified copy of each list, after which the town clerk shall deliver the several copies to the respective overseers of the highways of said townships.

SEC. 10. The overseers of highways shall give at least two days' notice to all persons assessed to work as aforesaid, living within the limits of their respective districts, of the time and places where and when they are to appear for that purpose, and with what implements.

SEC. 11. Every person liable to work, as provided for in this act, may commute for the same at the rate of one dollar per day, in which case such commutation-money shall be paid to the chairman of the board of supervisors, to be applied and expended by him for the destruction of grasshoppers and their eggs, and he shall be authorized and required to hire and engage some suitable and efficient person to work in the place of said person so commuting, and to pay him the sum of one dollar per day for his services; and every person intending to commute for his assessment shall, within five days after he is notified to appear and work as aforesaid, pay the commutation-money for the work required of him by said notice, and the commutation shall not be considered as made until such money is paid.

SEC. 12. Every person so assessed and notified, who shall willfully neglect or refuse to commute or work as provided by this act, shall be guilty of a misdemeanor, and shall, on conviction thereof, be liable to pay a fine of not less than two dollars nor more than ten dollars, or by imprisonment in the county jail not more than ten days, or both, in the discretion of the court, in a suit to be prosecuted in the name of the State of Minnesota, in the same manner as is provided by law for prosecutions of misdemeanors.

SEC. 13. There shall be appropriated, out of any moneys in the treasury of this State not otherwise appropriated, for the purpose of carrying out the provisions of this act, the sum of one hundred thousand dollars.

SEC. 14. The board of county commissioners of any county in this State afflicted by grasshoppers shall have the right, if in their judgment they see fit, to employ one or more persons in each township in said county, with such implements or mechanical contrivances as may prove most efficient to destroy the grasshoppers, from the first day of April to the first day of August in each year, paying such persons either by the day or a specified sum for the amount captured and destroyed. The compensation of such person shall be paid out of the general fund of the county: *Provided further*, That parties employed and paid by the county commissioners shall not receive any other or further compensation under the provisions of this act.

SEC. 15. This act shall take effect and be in force from and after its passage.

Approved March 1, 1877.

This law, though doubtless framed with the endeavor to meet peculiar emergencies in Minnesota, always struck us as being much too complicated, and, in point of fact, as we have just seen, it was never enforced, and proved a practical failure.

NEBRASKA.

AN ACT to provide for the destruction of grasshoppers.

Whereas the State of Nebraska has, for the past three years, been devastated by the grasshoppers, thereby greatly injuring the agricultural and commercial interests of the State; and whereas these interests are liable to be seriously damaged in the future by the recurrence of the pests aforesaid: Therefore,

Be it enacted by the legislature of the State of Nebraska:

SECTION 1. That the supervisors of each road-district in this State shall, at the time

when the grasshoppers shall have been hatched out, and before the same shall become full-fledged and fly, notify each able-bodied male resident of his district, between the ages of sixteen and sixty years, to perform two days' labor, at such time and at such place and in such manner as shall by said supervisors be deemed most efficient in the destruction of the grasshoppers; said notices shall be given in the same manner as is provided by law for the notice to work upon public highways.

SEC. 2. Cities of the first and second class shall be governed by the provisions of this act, and it shall be the duty of the mayor of such cities to appoint not exceeding two supervisors for each ward to oversee the labor to be performed under the provisions of this act.

SEC. 3. In case it shall appear that two days' work is not sufficient to destroy the grasshoppers in any district or ward, and it shall further appear that more time can be profitably employed in the destruction of the grasshoppers, the supervisors of each ward or road-district may require from the persons liable to the provisions of this act not exceeding ten days' labor in addition to the time hereinbefore mentioned; and it shall be the duty of such supervisor to give to each person who shall have performed labor under the provisions of this section a receipt for the number of days' labor performed, and the supervisor shall upon oath report to the city or county authorities the names and amount of labor performed by each person.

SEC. 4. It shall be the duty of all persons subject to the provisions of this act to attend when notified, as herein provided, and labor under the direction of the supervisor of their respective district or ward. Any person who, after being notified, shall refuse, neglect, or fail to comply with the provisions of this act, shall forfeit and pay to the county or city treasurers, as the case may be, the sum of ten dollars, together with costs of suit, which sum shall be collected by suit before any justice of the peace within the county, in an action to be brought in the name of the city or county.

SEC. 5. The supervisor shall report, under oath, to the city or county authorities the names of all persons who shall have refused or failed to comply with the provisions of this act.

SEC. 6. This being a case of emergency, this act shall take effect and be in force from and after its passage.

SUGGESTIONS THAT MAY BE OF SERVICE.

In addition to the foregoing remedial and preventive measures to be taken in dealing with locusts, a few other suggestions occur which may be of advantage. The plants that can be grown which are generally unmolested by the pests, and which will not, in all likelihood, suffer, have already been enumerated. Those which are cultivated are principally pease and other leguminous species, castor-beans, sorghum, broom-corn, tomatoes, sweet-potatoes, &c. Such wild plants to which the insects are particularly partial, as tansy, wild buckwheat, &c., might be periodically sprinkled with Paris-green water or powder, so as to kill the young locusts that feed upon them. Such plants might also be sown and encouraged around cultivated fields where the young insects are expected to hatch out. These young will also congregate on timothy in preference to other grasses or grain, and a strip of timothy around a corn or wheat field, to be poisoned in the same way, might save the latter. It is also currently supposed that the common larkspur (*Delphinium*) is poisonous to these insects, but how much truth there is in the statement we are unable to tell. "In going through an oat-field, the winged insects drop a great deal of the grain, which, when ripe enough, might at once be harrowed in, so as to furnish a good growth of fodder, that can be cut and cured for winter use. The lesson of 1873 and 1874 should also not go unheeded. The former year was one of plenty, and corn was so cheap and abundant that it was burned for fuel in many sections where in 1874 there were empty cribs, and the farmers wished they had been more provident.

Root crops of most kinds succeed admirably in the more northern portions of the locust country. Of the crops that would escape the ravages of the winged locusts, and which would grow in ordinary seasons and furnish excellent food for stock, may be mentioned turnips, rutabagas, mangel-wurzel, carrots (especially the large Belgian), parsnips, and beets. Of tubers that are not so profitable, but of which it would be well to plant small quantities in locust districts, for the reason that they grow with such ease and are less likely to be injured by the insects, the Chinese yam, Jerusalem artichoke (*Helianthus tuberosus*), and the chufa (*Cyperus esculentus*) are worthy of trial. Turnips, of which the insects are especially fond, kohlrabi, carrots, and the like, may be saved, when they come late, by cutting off the tops and covering the roots with earth, the tops making excellent food for milch-cows. The earth should be removed again as soon as possible to prevent the rotting of the roots.

The benefits of irrigation and the importance to the West of perfecting and enlarging the systems of irrigation now in vogue, we have briefly mentioned on page 127. With water at command, the farmer in all this locust area is measurably master of his two greatest insect plagues, the Chinch bug and this locust, and full master of the young locusts, either by inundating the land and drowning them out after hatching, or by using kerosene in the ditches; and if there were no other reasons to be urged in its favor, these are sufficient to warrant those States included in said area in using all means in their power in having schemes for irrigation perfected and carried out, so far as the topography, soil, and other peculiarities of the country will admit.

Hogs and poultry of every description delight to feed on the young locusts and will flourish where these abound, when nothing else does. It will be well, in the event of a future invasion, for the people in the invaded districts to provide themselves with as large a quantity as possible of this stock. It may occur that where no systematic efforts have been made to destroy the eggs or the young locusts, these will abound in such threatening numbers as spring advances that there is little prospect of saving the crops on individual farms amid the general negligence. Under such circumstances, unless one is prepared to vigorously carry out the means of destruction we have advised, it may be well to delay the planting of everything that cannot be protected by ditching until the very last moment, or till toward the end of June—using team and time solely in the preparation of his land. In this way not only will he save his seed and the labor of planting, and, perhaps, replanting, but he will materially assist in weakening the devouring armies. Where proper and systematic efforts had not been made in time, men planted in 1875 and worked with a will and energy born of necessity, only to see their crops finally taken, their seed gone, and their teams and themselves worn-out. "The locusts ultimately destroyed every green thing, until, finding nothing more, they began to fall upon each other and to perish. This critical period in their history would have been

brought about much earlier if they had not had the cultivated crops to feed upon; and if, by concert of action, this system of non-planting could at first have been adopted over large areas, the insects would have been much sooner starved out and obliged to congregate in the pastures, prairies, and timber. Moreover, the time required for early planting and cultivation, if devoted to destroying the insects after the bulk of them hatch out, toward the end of April, would virtually annihilate them. The multiplication of any species of animal beyond the power of the country to support it, inevitably proves the destruction of that species, unless it is able to migrate. Let fifty batches of canker-worm eggs hatch out on a single somewhat isolated apple-tree, and not one worm will survive long enough to mature. The leaves of the tree will be devoured before the worms are half-grown, and the latter must then inevitably perish; whereas, if only a dozen batches of eggs had hatched on that tree, the worms might all have lived and matured. In the same way, the young locusts inevitably perish whenever they are so numerous as to devour every green thing before they become fledged; and in certain circumstances, the sooner such a condition of things is brought about the better. The greatest generals and the mightiest armies must yield to starvation.

"Grain might also be sown in 'lands' or strips, fifty to one hundred feet wide, to permit of ditching between them, and those who have fall wheat up and doing well, where the eggs are thickly laid, should make ditches at intervals through the field to facilitate the saving of the grain in the spring."

In the cultivation of corn, or any crop that needs cultivation while growing, it is very desirable to keep the surface of the ground well stirred and pulverized by harrow or plow. The young insects dislike a pulverized surface, while the mature females also dislike it for oviposition.

"As a means of assisting farmers in the destruction of the unfledged locusts by trenches and in other ways, I would also urge the employment of the soldiers, a large force of whom, in times of peace, could be ordered to the field at short notice. To many, the idea of employing soldiers to assist the agriculturist in battling with this pest may seem farcical enough, but though the men might not find glory in the fight, the war, unlike most other wars, would be fraught only with good consequences to mankind. In Algeria the custom prevails of sending the soldiers against these insects. While in the south of France last summer [1875], I found to my great satisfaction that at Arles, Bouche du Rhône, where the unfledged locusts (*Caloptenus italicus*, a species closely allied to our Rocky Mountain Locust) were doing great harm, the soldiers had been sent in force to do battle with them, and were then and there waging a vigorous war against the tiny foe. A few regiments, armed with no more deadly weapons than the common spade, sent out to sections of country that are suffering from locust ravages, might in

a few weeks measurably rout the pygmean army, and materially assist the farmer in his ditching operations.

"As to the best means of disposing of the slaughtered locusts, the easiest and most generally employed are burning and burying. Yet the insects might be turned to good advantage as manure, or sun-dried and preserved in cakes to feed to hogs, poultry, &c., and where large quantities are destroyed under a bounty system, some such means of making the most of them should be considered.

PREVENTIVE MEASURES AGAINST THE WINGED INSECTS.

The remedies and means so far recommended in this chapter look to the destruction of the insects when once they have fallen upon the more fertile country, or are hatching or likely to hatch therein. We hope we have shown that it is quite possible to cope with the young insects under almost any circumstances, and that this part of the locust problem may be considered solved. It was to this part of the problem, also, that the labors of the Commission were more particularly devoted during the last year, because the season was most opportune for that purpose; and we have already pointed out in the introduction that our labors in this line prevented a complete and exhaustive study of the other part of the problem, viz, how best to prevent the winged insects from overrunning the more fertile country or the Temporary region in which the species is not indigenous. It is to this part of the problem that the Commission intends to direct its efforts in future, with every hope of success, and it is for this purpose of rendering the investigation as complete as possible that we have appealed to Congress for the means.

The coming season will be as favorable for the solution of this second part of the inquiry as the past was for that of the first part; since there is no further need of spending time in the Temporary region, and we shall find a normal state of things in the permanent region. Not until we have devoted another season (and perhaps several will be required) to the work, shall we be able to satisfactorily answer the great question that is so frequently asked: "Cannot something be done to protect the farmer from the flying swarms?" in other words, "to prevent the migrations of the winged insects from their permanent breeding-grounds, to which, in ordinary seasons, they are confined?"

For the present we must content ourselves with pointing out the possibilities in the case, so far as our last year's experience has thrown light on the subject. Of the different means that have been suggested by which to avoid the incursions of the winged hordes from the Northwest the following may be mentioned: 1. The protection and encouragement to the increase of the native locust-feeding birds. 2. The introduction of foreign locust-feeding birds. 3. Inducements offered to the Indians to collect and destroy the eggs and young. 4. Destroying the eggs or young by making the greatest possible use by artificial means of the natural water-supply. 5. Burning the young in spring. 6. Diverting winged swarms by means of smoke.

While every one of these suggestions might be carried out in exceptional cases to advantage, and it is the intention of the Commission to endeavor to acclimate certain foreign locust-feeding birds; yet the last two methods are the only ones which at present we have any faith in as capable of sufficiently general application or as resulting in general good. The first question to consider is whether the insects can be prevented from migrating from their permanent breeding-grounds, and—considering excessive multiplication the immediate cause of migration—this virtually means whether they can be prevented from becoming excessively multiplied in such breeding-grounds. At first view it would seem hopeless to attempt anything of the sort, and a year ago we had such a vague and imperfect knowledge of these permanent breeding-grounds that any proposition looking to wholesale destruction of the insects in them would have appeared Utopian. But we have learned enough of the laws governing the movements of the species and of the country designated as the Permanent region to give us faith, not only in the possibility of thus keeping the species in check east of the Rocky Mountains, but in its feasibility.

There is a popular notion that this pest breeds in and comes from sandy, desert countries. It is a popular error. The insect cannot live on sand, nor does it willingly oviposit in a loose, sandy soil. It does not thrive on cacti and sage-bush. It flourishes most on land clothed with grass, in which, when young, it can huddle and shelter. It can multiply prodigiously on those plains only that offer a tolerably rich vegetation—not rank and humid, as in much of the prairie of Illinois, Missouri, &c., but short and dry—such as is found over much of the prairies and plains of the Northwest. Now, the destruction of the eggs, which is so practicable and effectual in settled and cultivated sections, is out of the question in those vast unsettled prairies; but the destruction of the young locusts is possible. Those immense prairies are not only susceptible of easy burning, but it is difficult to prevent the fire from sweeping over them. Some system of preventing the extensive prairie-fires in autumn that are common in that country, and then subsequently firing the prairie in the spring, after the bulk of the young hatch, and before the new grass gets too rank, would be of untold value if it could be adopted. The more we study the question, and the more we learn of those breeding-grounds, the more feasible the plan grows in our minds. The Dominion Government has, fortunately, a well-organized mounted police force, which constantly patrols through the very regions where the insects breed north of our line. This force is intended to see that the peace is kept, to watch the Indians, to enforce the laws, and perform other police duties. It could be utilized, without impairing its efficiency as a police force, in the work we have indicated, or it might be augmented for that same work. We have conversed with the ministers of agriculture and of the interior, and with Governor Morris, on the subject, and they see nothing impracticable in the plan. Indeed, it was suggested by Mr. Dawson in his first

report on the subject of locust ravages in British America, and by Mr. Riley in his eighth Missouri report, for 1875 (p. 132). We have, on this side of the boundary line, a number of signal stations and military posts in the country where the insect breeds. We would have our own military force co-operate with the Dominion police force as a locust vigilance committee. Under the intelligent guidance and direction of some special commissioner or commission, we would have that whole country systematically studied every year by such a force with reference to the abundance or scarcity of the locusts. We would have such a vigilance force, by a proper system of fire-guards and surveillance, prevent the fall fires in sections where the insects or their eggs were known to abound, in order to burn them at the proper time the following spring.

This would be a stupendous work, and perhaps too expensive ever to be carried out, did the insects breed over the whole of the region we have designated as the permanent region; but, fortunately, the breeding-grounds are in limited areas in this region, comprising the richer valleys and plateaux and strips along water-courses. It is for the Commission to accurately map out in detail these areas, and to estimate with what force and at what expense to the two governments the work can be performed. We have no hope nor idea that the pest can ever by human means be exterminated from that vast region, but do believe that it may be so kept in check that it will not migrate. The constant expense will be limited to the employment of the necessary force, and only at intervals when danger threatens will it be necessary to go to the extra and exceptional expense of destroying the insects. Again, as may be gathered from Chapters VII and XV, there is a connection between locust-increase and seasons of drought, and we may take advantage of this knowledge by making especial effort whenever the character of the seasons indicate danger.

The next question to consider is, whether the farmer can be protected from the invading swarms, in case the above-mentioned plans should fail and the insects had become numerous. We think that this is also, to a large extent, possible with the proper system and organization. We would, in such an event, have this same corps of observers watch carefully the development and movements of the locusts and forewarn the farmers of the country of threatened danger. There is no reason why the agricultural community should not be informed the previous autumn as to the extent to which eggs have been laid, and as to the particular locations where laid; or why the following spring they should not be informed of the prospects, so as to plant accordingly as recommended in Chapter XIII, *i. e.*, put in a larger area of small grain that will be harvested before the winged swarms appear, and plant such crops as are best protected. Then, as the insects were commencing to migrate, their movements should be communicated to the people through the Signal Bureau. The information should be as minute, complete, and prompt as possible. These movements may be likened to those of a storm, and the people should receive in advance the danger signal, that

they might guard against calamity. The "locust probabilities" are of far more importance than the weather probabilities to the people of the West, and the idea of having them telegraphed over the country does not appear half as chimerical to us now, as that of having the weather foreshadowed did a few years ago.

In this way the farmers could be fully forewarned of approaching danger. We would, in this connection, have the Western farmers adopt some general plan of defense against possible invasion. The straw that is now allowed to rot in unsightly masses as it comes from the thrasher, and which encumbers the ground unless burned, should be utilized. Let it be stacked in small pyramids at every field-corner, and there let it remain until the locusts are descending upon the country. Then let the farmers in a township or a county or in larger areas simultaneously fire these pyramids, using whatever else is at hand to slacken combustion and increase the smoke, and the combined fumigation would partially or entirely drive the insects away, according as the swarm was extended or not.

In short, we believe, first, that by proper co-operation on the part of the two governments interested, the excessive multiplication of this destructive insect may be measurably prevented in its natural breeding-grounds, and that the few thousand dollars that would be necessary to put into operation intelligent co-operative plans are most trifling in view of the vast interests at stake. With an efficient and properly organized Department of Agriculture, liberally supported by Congress; with the aid of the War Department, the Signal Bureau, the Post-Office Department, and the Indian Bureau, the plan could be perfected and carried out at minimum expense. There is no reason why every signal officer, every postmaster, every mail-carrier, every Indian agent, and every other government employé in the Permanent region should not be ordered to do service of this kind, and made, under the direction of an intelligent head, a medium through which to gather the desired information. We believe, secondly, that where the multiplication of the insect cannot be prevented in its natural breeding-grounds, our farmers in the more thickly-settled sections may, by the use of smoke, measurably turn the course of the invading swarms and protect their crops—obliging the insects to resort to uncultivated areas.

Did the injury continue for another three or four years as it has for the past four; were the Western farmers to suffer a few more annual losses of $40,000,000, such schemes as we have suggested would soon be carried out. The danger is that during periods of immunity, indifference and forgetfulness intervene until another sweeping disaster takes us by surprise. The other danger is that the majority of our Congressmen and Senators at Washington, representing constituencies never troubled with this grievous pest, have not, and cannot well have, any just conception of the magnitude of its devastations, and are consequently without due appreciation of the importance of the subject.

CHAPTER XIV.

INFLUENCE OF PRAIRIE FIRES ON LOCUST INCREASE.

"The statement has been often made, and advocated with considerable ingenuity, that the visitations of the Rocky Mountain locust are due to the practice of burning off the dry grass of our Western prairies. All the arguments in this direction, however plausible at first sight, will not bear the test of close scrutiny. The theory is that burning the grass is the occasion of drought, and that locusts come only in droughty seasons. One writer in the *Kansas Farmer* for September 23, 1874, even asserts that 'the unbroken succession of curses' that have afflicted that State, 'all spring from the one first grand cause, the burning of the prairie grasses,' and, after explaining that hot, scorching winds and simoons originate in desert countries, he avers that 'it matters not whether the country is an original desert, or whether it is made so by the action of our Western prairie fires. For all present purposes the two are reduced to a common level and produce a common result—drought, hot winds, and locusts.'

"The reason given why the locusts can come only in droughty seasons is that they cannot fly in a moist atmosphere, and the facts that they do not readily fly early in the morning, and that the farther east you go, or, in other words, the more moist the atmosphere becomes, the insects diminish in number and consequent power for harm."

As such views are by no means uncommon in the West, we adduce several reasons for believing that there is no connection whatever between prairie-fires and locust ravages.

"1. It is by no means proved that the simoons which occasionally sweep over our Western States and Territories have their origin in any part of that vast prairie country. Some of the more local of these hot, dry winds may originate or acquire their peculiarly high temperature on the *mauvaises terres* of Wyoming or the tablelands of Arizona and Mexico; but the more general simoons most probably have their origin at a far greater distance from us, viz, in the tropics. These simoons in Missouri always blow from the southwest, in Kansas from south-southwest, and in Eastern Colorado from the south, or a few points east of south; and their injurious and scorching effects are not infrequently felt before the frost in Kansas and the country to the west is fairly out of the ground.

"2. It is well known that the buffalo-grass ranges over a vast extent of our Western plains, and that it does not furnish a very dense or thorough covering, even when unburned, and assists very little in retaining moisture or preventing evaporation.

"3. Our own observations for the past seventeen years in this Western prairie country lead us to the conclusion that fires more often succeed than precede drought, and that they may more justly be looked upon as

a result than as a cause of excessive dry weather; and the prevailing belief that large conflagrations or extensive fires are conducive to rain, bears on this point.

"4. Whenever grass is burned during the growing season, the old and drier blade is soon succeeded by a green and succulent one, which has far greater power to attract and retain moisture; while if burned in winter-time, the evaporation from the soil can be thereby but slightly affected, because of the weakened power of the sun and the snows which usually cover and protect.

"5. Droughts are by no means confined to that portion of the country subject to the locust invasions.

"6. The reason why locusts are more sluggish and less inclined to fly at morn than at noon is not so much a question of the comparative density of the atmosphere as of the difference in temperature. All diurnal insects are sluggish in the cool of the morning, and their activity increases with the rising of the thermometer; and flight, whether of bird or insect, is, we conceive, easier, *cæteris paribus*, in a dense than in an attenuated atmosphere.

"7. As the Rocky Mountain locust multiplies continuously in the Permanent region, its descent into the plains and prairies to the east and south, where it does not permanently thrive, cannot well be affected by the burning of the grass on these plains and prairies.

"From what has preceded we think we may safely conclude that the non-burning of the prairies will have no effect in preventing locust injuries, but that, on the contrary, as shown in Chapter XIII, the judicious burning of such prairies at the proper time is most beneficial and highly to be commended.

"Indeed, there is only one way in which there can be any real connection between the burning of prairies and the ravages of the Rocky Mountain locust, and that connection is through the remote past, and altogether beyond our present control. In the report of the Chief Signal Officer to the War Department for 1872 will be found an interesting account of the great fires of 1871 in the Northwest, in which the late Prof. J. A. Lapham, of Milwaukee, Wis., maintains that our extensive Western prairies and plains owe their existence and origin to the agency of fire. These fires, encouraged by drought, and either kindled by accident or intention, have swept over the country for ages, and while they leave the roots of the grass uninjured, they destroy the germs of most other plants, including forest-trees; and Mr. Lapham pictures to himself a long-past struggle between forest and prairie, in which the latter, by the assistance of the Fire King, has gained and held the vantage-ground.

"While we do not agree with Professor Lapham that the remote cause of our prairies can be attributed to fire, yet no one can doubt its agency at the present time in maintaining these prairies and preventing timber-growth in the more humid portions of the great prairie regions.

But on Professor Lapham's hypothesis there would naturally be a connection in the past between fires and locusts; for if, without fires, this whole prairie region had been timbered, the locusts, which are essentially insects of the plains and prairies, could never have become so prodigiously abundant and injurious. On such a hypothesis alone can we see any possible connection between prairie-fires and locust invasions; and, however much truth there may be in the hypothesis, the fact remains that there is no present connection between the two phenomena."

CHAPTER XV.

INFLUENCE OF WEATHER ON THE SPECIES.

Although we cannot doubt that the climate of the Rocky Mountain region and of the plains where the Rocky Mountain locust dwells, determines largely its characteristics, habits, and destructiveness, yet the want of accurate simultaneous observations from numerous points still prevents us from entering into that systematic investigation of the subject that would thoroughly elucidate such questions as are still obscure.

On the one hand, we know from observation in a general way (1) that the species comes to perfection in what we have (Map I) designated as the Permanent region, which is elevated from one to four thousand feet above the sea; (2) that it migrates by flights, to some extent westward, but especially eastward to Manitoba and southward to Texas, rarely passing the 94th meridian on the east or to within fifty miles of the Gulf of Mexico on the south; (3) that the progeny born in these low lands return, as far as they are able, to the higher regions near the birthplace of their ancestors.

On the other hand, we consider that the meteorological conditions affecting their life most probably are: (1) The temperature of the soil in which the eggs are deposited; (2) The indirect effect of climate by its influence on the condition of the young grasses and plants at the time of hatching of the young and up to the period of the insect's acquiring wings; (3) The temperature, rain-fall, and dryness at the surface of the ground during the unfledged condition of the young locust; (4) The winds and weather prevailing when the insect is ready to migrate; (5) The nature of the vegetation, soil, and climate in the region to which it migrates and where the eggs are to be laid.

With respect to migrations, the meteorological bearings on them have been considered in Chapter VII; the other vital questions in regard to the increase and the perpetuity of the species, and therefore in regard to its permanent destructiveness, relate to the conditions to which the eggs and the young insects are subjected, and will be considered in the present chapter.

EFFECT OF THE WEATHER ON THE YOUNG LOCUSTS.

That the young locusts thrive best and are healthiest during dry springs and summers, is not only what we should naturally conclude from what we know of the climatic character of the permanent habitat of the insect, but it is proved by experience. Excessive moisture, especially when accompanied with cold, is prejudicial to them. They can stand a slight frost with impunity, but 15° below freezing-point usually kills them.

EFFECT OF THE WEATHER ON THE EGGS.

While a knowledge of the influence of the weather on the young locusts can have no especial practical bearing, since we can never know beforehand the kind of weather we are to have, it is quite different in regard to the eggs. There is a possibility that by knowing the conditions most favorable or most unfavorable to the eggs, and the thermal constant required to properly hatch them, we may be able to anticipate results. It is evident that if the amount of heat which the locust-egg has received is the principal factor in determining its development, we ought, having once determined this thermal constant, and having a series of daily observations of the temperature of the earth in which the egg lies, to be able to state on any day in the early spring just how near the egg is to hatching; and this information would, it is conceived, frequently be of use to the farmer, since he would know then whether it would be safe to plant or best to delay. For instance, if in Missouri, by April 1st, the eggs are within two days of hatching, and the weather indications of the Signal Office predict continued warm or very warm weather, we may anticipate that the eggs will surely hatch in a few days, and that succeeding cold spells and rain will kill off the early young locusts.

Of course such predictions will have only special and local value, and for their success must depend on the accuracy of our knowledge of (1) the temperature of the soil, and (2) the thermal constant or total amount of heat required to hatch the locust-egg. The chemical effects of solar radiation we believe to be of minor importance, since the solar rays that penetrate into the soil belong to the red end of the spectrum.

In a broad way we know, from the sub-boreal nature of the insect, that its eggs will stand intense cold, for they are normally laid where the winters are long and intense. We may therefore assume that a severe and steady winter in the Temporary region will better preserve them and cause them to hatch more regularly in spring than a mild and changeable winter; and the history of the winter of 1874–'75, compared with that of 1876–'77, bears out the assumption. In other words, the more nearly the winter of the Temporary region approaches in character that of the Permanent region, the better will the eggs be preserved; and the relative mildness of the winter in the more southern latitudes—the alternate freezing and thawing, and corresponding check and stimulus

to development which the eggs there endure—has no doubt much to do with the degeneracy of the young locusts that hatch in the Temporary region. Having already arrived, by experiment (Chapter XIII), at an approximate knowledge of the influence of moisture, and of alternate freezing and thawing on the eggs, we desire in the present connection to ascertain, as nearly as present data permit, the mean temperature or thermal constant at which the eggs will hatch. Experience with this, as with other insects, indicates that there will be constitutional peculiarities belonging to different individuals which will cause irregularity in development even under the same conditions; but we must recognize exceptions to all conclusions, and desire to ascertain as far as possible the rule.

The following study, which, though necessarily incomplete, affords the first approximation toward the exact determination of the effects of temperature on the time of hatching of the eggs, has been made for us by Prof. Cleveland Abbe, of Washington.

THE TEMPERATURE OF THE SOIL.

On this fundamental question our positive information is meager and unsatisfactory. We need for our Western States observations of daily maximum and minimum temperatures, or better, four observations a day, at regular hours, of the temperature of the soil at depths of 0, 1, and 2 inches, within such soils and exposures as are selected by the locusts for their eggs. But we are not aware that any such observations have as yet been made anywhere in the United States, and shall therefore be obliged to depend upon some general conclusions drawn from European observations of soil temperature. On this account, and until such observations are instituted in our own Western regions, our investigations will be liable to a considerable range of uncertainty, and we can only indicate general results instead of illustrating our method by definite special cases.

It is to be earnestly recommended that in future careful observations on the temperature and moisture of the soil be made in connection with the usual record of temperature and moisture of the air, the rain-fall and wind, and cloudiness of the sky. Amateur meteorological observers frequently spend money and time upon barometrical observations that would be more profitably spent upon rain-fall, moisture, and temperature.

We have prepared unpublished tables, which suffice to illustrate the very various temperatures of the soil under similar atmospheric temperatures, depending upon the nature of the soil, exposure, time of day and year, cloudiness, rain-fall, wind, &c. In order to aid in forming an approximate judgment of the temperature to which eggs must have been exposed, it will be necessary to remember that during a few hours on sunny days the temperature within one inch of the surface of the ground is decidedly higher than would be inferred from the observations at

2 or 3 inches, and of course much higher than the air temperature at an elevation of a few feet. According to Hennessey, Prestel, &c., a black-bulb thermometer laid upon the soil probably gives one limit, and the ordinary air temperature the other limit, between which the temperature of the surface soil must be included. An approximate estimate of the relative temperatures for slight depths at midday may be formed from the accompanying table for dry, light, sandy soils, bare of grass:

	100° F.	80° F.	60° F.	40° F.
On surface				
Just below	90	72	55	41
One-half inch below	80	67	52	42
One inch below	75	63	51	41
Two inches below	70	60	50	40

THERMAL CONSTANT FOR LOCUST-EGGS.

The next step in our study requires that we should determine, if possible, for how long locust-eggs must be exposed to a given temperature in order to hatch, or what total amount of heat must be furnished to them, which amount may be entitled the thermal constant in analogy with the similar determination for the seeds of plants. We of course have to assume that the large majority of the eggs require a certain normal amount of heat. The effect of temperature, and incidentally of rainfall and dryness of air, upon the eggs is shown by Mr. Riley's experiments, recorded in Chapter XIII. We add the following observations which have come to hand from other sources:

The young that are hatched out in February, if caged or in a warm place, may be kept lively for a long time, but those that appear in the open air at this season soon succumb to cold nights and want of food. It is certain that those that appeared in February will do no harm next spring. It is doubtful whether in the year most favorable to their development more than 50 per cent. of the eggs in this climate ever survive the winter in a healthy state. While it is possible for these eggs to survive one or even two freezings after the insect has formed in the egg, they are nearly destroyed by frequent severe changes of weather.—[Prof. S. Aughey in the *Nebraska Farmer*, March, 1877.

It seems to be true that the vitality of the egg cannot be destroyed by freezing, but it is more than likely that a rapid thawing out would spoil them. I have subjected grasshopper eggs to temperatures 20 and 30 degrees below freezing, and then, upon examination with the microscope, found the contents fluid, but thick, and with ice crystals penetrating the mass. I have also tried freezing and thawing and then hatching. Some 'hoppers appeared from the eggs that were thawed slowly, but none where the temperature was raised with any rapidity.—[G. E. Bailey in *Nebraska Farmer*, March, 1877.

Eggs exposed to 78° F. hatch in from 7 to 14 days; exposed to 20° F. they were frozen, but revived on being warmed; exposed to a temperature of 5° F. they were killed. A hard frost does not kill many grasshoppers, but a cold of from 15° to 0° will kill with hardly any exception. The eggs are not destroyed by a cold winter unless they have already been partly hatched.—[Smith & Trask, of the *Farmers' Union*, Saint Paul, Minn.

An anonymous correspondent of the *Rural New Yorker*, March 31, 1877, says: A temperature of 100° F. had no effect on the eggs, which hatched out in a few hours. A

temperature of 120° made the 'hoppers lively and happy, but at 140° they quickly died.

Mr. B. Yates, in the Saint Paul *Pioneer-Press*, says that 'hoppers hatched out by stoves, when grown to one-fourth inch long, endured 15° and 18° below zero without injury.

Last winter, when the thermometer marked 24° below zero, I examined eggs in a piece of ground that had been bare all winter, and found them apparently as free from frost as so much alcohol, and in the spring they hatched out in great numbers in the same ground.—[W. J. Newell, Athol, Sioux County, Iowa, July 2, 1877.

Eggs laid in September, 1876, began to hatch about April 10th. Very cold weather April 24 to 29. Many eggs began to hatch rapidly on May 1st. Insects exposed in a bottle to 14, were not injured.—[G. V. Swearingen, Sidney, Iowa, May 1, 1877.

On the 27th May, 1877, at Montevideo, Chippewa County, I found a place where the hatching had begun in the early part of the month and had been suddenly arrested by rain; the egg-pods were found to be spreading, the young having been arrested just as they were in the act of breaking the shell. The eggs appeared to be lifeless, but after lying in the warm sun a few minutes a portion of the young came forth. * * * * Eggs plowed under in the spring in corn-fields remained unhatched until June 21, and were then apparently lifeless, but hatched under the sun within an hour. Where the ground has become baked hard by the sun, a light rain-shower, followed by warm sunlight, often serves to assist rather than to hinder hatching.—[Mr. Allen Whitman, Saint Paul, Minn.

Eggs deposited July, 1875, and covered by water through the spring and summer to August first, were hatching out on August 28 in the warm sun. Alternate freezing and thawing occur every year; thus March, 1874, had sixteen days of temperature above 32°, and it fell, April 3, to 17°. In March, 1875, ranged from 38° to 1°, and in April, 1875, the range was from 57° to 10°. In March, 1877, above freezing-point, and on eighteen days in April.—[C. H. Goodsell, Marshfield, Lincoln County, Minn.

Notwithstanding the indefinite nature of some of the preceding observations, we have ventured to draw the following conclusions in reference to the influence of temperature, &c., on the vitality and hatching of the eggs:

I. Low degrees of cold, as — 5° F. and — 24 F., do not impair their vitality.

II. Temperatures up to 100° F. do not destroy them.

III. Moisture and water affect the eggs principally by keeping them at a low temperature and delaying the time of hatching; by drying up the contents of the egg, by exposure to sun and wind, its development may be prevented at any temperature.

IV. Alternate freezing and thawing injures the eggs but slightly if the process is slow, but if the thawing takes place very rapidly the vitality is probably injured.

V. The development of the egg is suspended for an indefinitely long time when kept at temperatures uniformly lower than 32° F., and even probably lower than 50°, but progresses at higher temperatures with a rapidity proportional to the excess of the temperature above 50°.

VI. Some of the preceding experiments give the following numerical data for the time of hatching:

Eggs that had perhaps been already brought forward by natural heat out of doors, hatched after 20 days' exposure indoors to an artificial temperature ranging from 55° at night to 65° by day, and averaging 60°. Other eggs, perhaps those that had not as yet made so much progress in maturing, required 38 days at the same temperature.—[Riley's Experiments, 1.

Eggs hatched in from 21 days, at 60° F., to 32 days, at 60° F.—[Riley's Experiments, 2.

Eggs hatched in from 21 days, at 60° F., to 36 days, at 60° F. These eggs were exposed from December 22 to January 12 to out-of-doors temperatures ranging from

52° to —4°, without injury or material hastening of the hatch.—[Riley's Experiments, 3.

Eggs, out of doors, at Saint Louis, from November 15 to March 2, and therefore exposed to 80 days of maximum temperature lower than 51°, and 20 days of maximum temperature over 58°. The eggs continued hatching from March 2 to April 10.—[Riley's Experiments, 6.

Eggs buried at Manhattan, Kans., November 10, at depths from 1 to 18 inches. Examined May 12, and had all hatched down to 12 inches, but none below that.—[Riley's Experiments, p. 356.

Eggs hatched in from 7 to 14 days at temperature of 78°. It is not known whether, in these experiments, the eggs were perfectly fresh, nor whether the temperature was perfectly uniform.—[Smith and Trask.

From these observations, and having in mind the irregularities in the time of oviposition, and the possibility of the previous exposure of some of these eggs to an unknown though small amount of natural heat before being subjected to the artificial experimental temperature, the following estimate or rather "working hypothesis" has been formed as to the approximate relation between the temperature and the time of hatching.[94]

At a uniform temperature of 50° Fahrenheit, the eggs require 65 whole days or, 1,560 hours.

At a uniform temperature of 60° Fahrenheit, the eggs require 60 whole days, or 1,440 hours.

At a uniform temperature of 70° Fahrenheit, the eggs require 55 whole days, or 1,320 hours.

Whether eggs will hatch on exposure to a *continuous* temperature much higher or lower than these may be questioned. Analogy shows that there must be a limiting temperature.

APPLICATION OF PRECEDING DATA TO THE ESTIMATION OF THE DATES OF HATCHING OF EGGS DEPOSITED UNDER NATURAL CONDITIONS.

In order to apply the estimates of the preceding section to the locust eggs actually lying in the ground, we must, in the absence of direct observation of the soil temperature, find some general connection between this and that of the air, as given by ordinary meteorological registers.

This connection has been more elaborately treated of by numerous authors; but for our case the question is simplified by the fact that we need only to have some general statement of the time during which soil temperatures exceeding 50° have prevailed For more accurate investigation, and assuming that the thermal constants of the preceding section can be determined with minute accuracy, we should imperatively need observations of the actual temperature of soil rather than any approximate inferences.

We propose for our present approximation to ascertain, first, on how many days during the months in question air-maxima of 50°, 60°, &c.,

[94] This estimate was made without knowledge of that given by Mr. Riley in Chapter VIII, where the times are given as 28 to 35 days, at a temperature of 85° Fahrenheit, or 42 days, at a temperature of 75° Fahrenheit, and at the moment of going to press there is not time to investigate the origin of this difference.

occurred, and on how many days the air-minima were above 50°. In a second table we shall give the average daily duration in hours of the period during which the average soil temperatures above 50° will average 60°.

The following tables, for September, 1875, to June, 1876, are principally based on data published in the Annual Reports of the Chief Signal Officer:

Table showing the number of days in which the maximum and minimum air temperatures were within certain limits.

FORT GARRY, MANITOBA.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	3	23	30	31	31	29	31	19	4	2
Between 50° and 59°	7	2	0	0	0	0	0	7	5	3
Between 60° and 69°	8	4	0	0	0	0	0	3	10	4
Between 70° and 79°	9	1	0	0	0	0	0	1	5	12
Between 80° and 89°	2	1	0	0	0	0	0	0	6	6
Over 89°	1	0	0	0	0	0	0	0	1	3
The minimum temperatures were above 49° as follows	5	0	0	0	0	0	0	0	4	15
Monthly mean temperatures	52°.3	36°.6	8°.9	5°.7	−4°.3	−6°.4	8°.7	35°.9	52°.8	60°.0

BRECKENRIDGE, MINN.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	1	13	24	31	31	29	31	17	2	0
Between 51° and 59°	5	8	5	0	0	0	0	6	7	3
Between 60° and 69°	11	3	1	0	0	0	0	6	8	6
Between 70° and 79°	9	5	0	0	0	0	0	1	5	12
Between 80° and 89°	3	2	0	0	0	0	0	0	9	5
Over 89°	1	0	0	0	0	0	0	0	0	4
The minimum temperatures were above 49° as follows	8	0	0	0	0	0	0	0	8	14
Monthly mean temperatures	55°.4	42°.0	18°.3	18°.0	6°.3	4°.3	10°.5	38°.3	56°.3	63°.1

YANKTON, DAK.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	0	6	20	24	26	23	31	7	3	0
Between 51° and 59°	4	8	8	6	5	5	0	10	3	1
Between 60° and 69°	10	9	2	1	0	1	0	7	4	6
Between 70° and 79°	5	5	0	0	0	0	0	5	10	9
Between 80° and 89°	11	3	0	0	0	0	0	1	11	10
Over 89°	0	0	0	0	0	0	0	0	0	4
The minimum temperatures were above 49° as follows	13	0	0	0	0	0	0	0	18	18
Monthly mean temperatures	60°.6	47°.2	35°.9	27°.3	18°.9	20°.8	20°.4	46°.7	51°.6	65°.7

NORTH PLATTE, NEBRASKA.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	0	2	18	16	26	13	22	7	2	0
Between 50° and 59°	3	7	8	12	5	13	5	3	5	0
Between 60° and 69°	5	8	4	3	0	3	4	10	7	5
Between 70° and 79°	10	8	0	0	0	0	0	8	7	10
Between 80° and 89°	7	6	0	0	0	0	0	2	10	8
Over 89°	5	0	0	0	0	0	0	0	0	7
The minimum temperatures were above 49° as follows	13	0	0	0	0	0	0	2	17	18
Monthly mean temperatures	62°.5	53°.4	31°.5	34°.0	23°.6	32.°4	27°.9	50°.3	59°.6	67°.9

DODGE CITY, KANS.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	0	0	8	7	11	4	18	3	0	0
Between 50° and 59°	2	2	10	8	11	12	7	3	2	0
Between 60° and 69°	3	8	4	14	8	8	4	6	8	2
Between 70° and 79°	7	11	7	2	1	5	2	9	4	8
Between 80° and 89°	10	10	1	0	0	0	0	7	15	10
Over 89°	8	0	0	0	0	0	0	2	2	10
The minimum temperatures were above 49° as follows	23	2	0	0	1	0	0	8	18	24
Monthly mean temperatures	68°.7	56°.6	39°.9	40°.7	35°.3	41°.5	34°.7	56°.6	64°.5	71°.2

CORSICANA, TEX.

	Number of days.									
	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Maximum temperatures were under 50°	0	0	1	0	4	2	1	0	0	0
Between 50° and 59°	0	0	6	4	9	3	8	1	0	0
Between 60° and 69°	2	2	14	15	12	12	10	4	2	0
Between 70° and 79°	8	14	5	12	6	12	9	8	6	2
Between 80° and 89°	6	14	4	0	0	0	3	16	17	11
Over 89°	14	1	0	0	0	0	0	1	6	17
The minimum temperatures were above 49°	29	20	12	11	9	10	9	25	26	30
Monthly mean temperatures	73°.5	63°.9	55°.6	54°.2	52°.2	53°.1	53°.9	67°.0	71°.8	77°.3

We shall make a pretty close approximation to the number of hours during which the eggs were exposed to a hatching temperature of 60° F. if we allow for each of the maximums above 50° in the preceding tables the number of hours given in the following table:

	Fort Garry.	Breckenridge.	Yankton.	North Platte.	Dodge City.	Corsicana.
1875.	*h.*	*h.*	*h.*	*h.*	*h.*	*h.*
September	12	14	16	18	20	24
October	6	0	11	12	18	20
November	.....	0	6	6	12	16
December	.....	.....	4	4	6	12
1876.						
January	.....	.....	4	4	6	12
February	.....	.....	4	4	6	12
March	.....	.....	.....	6	8	16
April	6	6	6	12	12	20
May	12	10	12	16	18	24
June	18	14	16	18	20	24

The total number of hours during which the eggs are exposed to a hatching temperature equal to 60° F. is now found by multiplying their number by the number of maximums above 50° as before given, and the following results are thus obtained:

Total number of hours during which eggs were exposed to a hatching temperature equivalent to 60°.

	Fort Garry.	Breckenridge.	Yankton.	North Platte.	Dodge City.	Corsicana.
1875.	*h.*	*h.*	*h.*	*h.*	*h.*	*h.*
September	324	406	480	540	600	720
October	48	180	275	348	540	600
November	0	36	60	72	264	464
December	0	0	28	60	144	372
1876.						
January	0	0	20	20	120	324
February	0	0	24	64	150	324
March	0	0	0	54	104	464
April	66	78	184	276	324	600
May	324	290	366	464	558	744
June	504	420	480	540	600	720

From this table we see that the eggs laid at Manhattan, Kans., in the fall of 1876, and obtained by Mr. Riley for his experiments early in November, may have already received as much as 1140 = 600 + 540 hours of a hatching temperature, or about 47 complete days, more or less, depending on their exposure, which was allowed for in framing the working hypothesis given in the preceding section.

By adding up the numbers in the initial column of the table just given, and comparing with our standard, 1,440 hours of temperature 60°, we find that the times at which the hatching would begin are about as follows:

Eggs deposited September 1, 1875.

At—	Will have received—	And begin to hatch—	Latitude.
			°
Fort Garry	1,264 hours of hatching temperature by June 30	Early in July, 1876.....	50
Breckenridge ..	1,410 hours of hatching temperature by June 30	.... do	46. 5
Yankton.....	1,407 hours of hatching temperature by May 31..	Early in June, 1876	42. 5
North Platte...	1,434 hours of hatching temperature by April 30	Early in May, 1876.....	41. 5
Dodge City	1,404 hours of hatching temperature by Nov. 30..	During December, 1875.....	37. 5
Corsicana.....	1,320 hours of hatching temperature by Oct. 31 ..	During November, 1875.....	32

This table shows the rapid development of the eggs in the region south of Kansas, where their hatching may, under favorable circumstances, begin in December, though those born then will be killed by the cold that would not have injured their eggs. For Minnesota, Nebraska, and Kansas our table agrees well with the hatching times of the majority of the insects as reported in Riley's Locust Plague, page 97. For Manitoba our data are rather later than that given by Riley, but would correspond to the region north of Dakota and Montana. In general, however, it is apparent that a revision of these figures in the light of careful observations to be made in the future will confirm the general accuracy of the present method of computing and predicting the times of hatching, and will give data for much more accurate calculations.

CHAPTER XVI.

EFFECTS THAT GENERALLY FOLLOW SEVERE LOCUST INJURY.

There are some interesting consequences that usually follow severe locust injury, and that are well worth recording. Not to dwell on the immunity which, as we have seen (pp. 247–8), the farmer is likely to enjoy the year following severe injury from the young insects, there is invariably, throughout the Temporary Region, a marked

CONTRAST BETWEEN SUMMER AND AUTUMN.

"After the insects have left, or by the end of July in the latitude of Saint Louis—earlier or later as we go south or north—the ravaged

country begins to wear a bright and promising aspect, in strong contrast with the desolation of a month before. In August the contrast becomes still more gratifying, and frequently there are grown the finest crops of corn, Hungarian grass, prairie meadow, buckwheat, and vegetables of all kinds. In September the change which three months have wrought needs to be seen to be appreciated. Root crops do well, and vegetables of all kinds attain immense proportions, owing to the freedom from weeds and fertility resulting from the dung and bodies of the dead locusts.

NO EVIL WITHOUT SOME COMPENSATING GOOD.

"Not to mention the valuable experience and the quickening influence that are generally gained in temporary adversity, there are other ways in which good may grow out of the locust troubles when they are severe. The chinch bugs filled the air in the spring of 1875 throughout the stricken district, and many persons feared that they would destroy the corn crop even if the locusts left. We then argued that there was no danger of such a result, and that there was every reason to expect less injury from this cause than usual, and with a wet summer, which might be expected, an almost total annihilation of the pest. With everything eaten by the locusts, the female chinches, instead of being quietly engaged, unseen, in laying eggs, as they usually are in May, were flying about seeking plants on the roots of which to deposit their eggs. For this reason they were more noticeable. Once fully developed in the ovaries, the eggs must be laid, and the great bulk of them were necessarily laid where the young hatching from them were destined to perish, as the result proved; for, injurious as the species had been for the two or three previous years, scarcely a specimen was to be found in the fall. The same will hold true of many other insect pests, which are starved out in the spring by utter devastation of their food-plants; and such a devastated country is apt to be free from most noxious insects during the subsequent two or three years.

"The unusual productiveness of the soil in the stricken country was on all hands noted during the year 1875, and was owing, in no small degree, to the rich coating of manure which the locusts left. In the form of excrement and dead locusts, the bulk of that which was lost in spring was left in the best condition to be carried into the soil and utilized. The introduction of new seed from other States was also beneficial.

"Nature generally maintains her averages, and whenever diminished southern winds, drought, and locusts have prevailed, the opposite conditions are very apt to follow, and give us plenteous harvests in the place of short crops.

CHANGES THAT FOLLOW THE LOCUSTS.

"The invasions into a country of large numbers of animals, whether men or insects, are often followed by changes in the vegetation of that

country. Certain strange plants are said to yet mark the path through the Southern States which Sherman's soldiers took in their march to the sea, and a number of plants new to the country are known to have been introduced into France by the Germans during the late Franco-Prussian war. So the locust incursions and devastations in Kansas and Missouri were followed by some curious changes. These changes consisted mostly in the great prevalence of plants that in ordinary seasons are scarcely noticed. The *Amarantus blitoides*, already spoken of (p. 254), spread at an unprecedented rate, and grew in great luxuriance. Immediately after

FIG. 106.—GREEN LARVA OF WHITE-LINED MORNING SPHINX. (After Riley.)

the locusts left, the common purslane started everywhere and usurped the place of many other species. The common Nettle (*Solanum Carolinense*) and the Sand burr (*S. rostratum*) spread in 1875 to an alarming degree, and the Poke-weed (*Phytolacca decandra*) was very abundant. All kinds of grasses grew very luxuriantly during the summer, a fact due to the wet and favorable weather; but some kinds[95] that are rare in ordinary seasons got the start and grew in great strength and abundance. Among these none are more notable than the sudden appearance very generally over the locust-devastated region of what is usually called a new grass. Springing up wherever the blue grass gets killed out, it proves a Godsend to the people, for while it is young and tender, cattle like it and fatten upon it. This grass is the *Vilfa vaginæflora*, an annual which is common from the Atlantic to the Rocky Mountains. Unnoticed during ordinary seasons, the destruction of the blue grass and other plants by the too close gnawing of the locusts gives it the advantage in the struggle for existence—an advantage which is soon lost, however, as the nor-

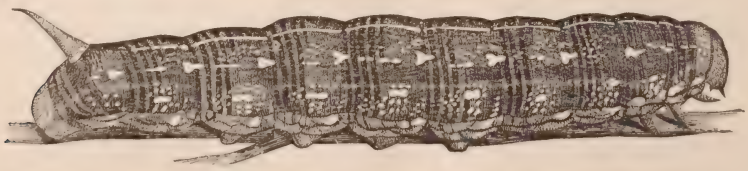

FIG. 107.—BLACK LARVA OF WHITE-LINED MORNING SPHINX. (After Riley.)

mal relations between species are assumed again in a few years after the disturbing influence has ceased to be operative. Indeed, since the Vilfa

[95] Prof. G. C. Brodhead (Trans. St. Louis Ac. Sc. III, p. 348) mentions more particularly *Aristida oligostachya*, in ordinary seasons of rare occurrence around Pleasant Hill, as reaching the unusual height of two feet, and being very abundant. *Eragrostis poæoides*, ordinarily recumbent and scarcely noticed in yards and along roads'des, grew in profusion, and three and a half feet high, "looking like meadows ready to be mowed." *Panicum sanguinale* was luxuriant enough to be cut for hay.

ripens and dies early in the fall, the blue grass gains ground the very first year, and afterward easily retains supremacy. The wide-spread appearance of the Vilfa, following the locusts, has been explained on the hypothesis that the latter brought the seed from the West and passed it undigested with their droppings. The fact that the seed is a line long, and not particularly hard, aside from the other facts in the case, renders such a hypothesis unreasonable. Being an annual, the seed was scattered the previous fall, and naturally starting, we may presume, about the time the insects left, the species got the ascendency.

"Some persons were quite alarmed at the prevalence of large green and black worms soon after the locust left. Feeding upon purslane and prevailing to an unusual degree, because of the unusual prevalence of this plant, they generally did good by keeping this weed down and converting it into manure. In some few instances, however, they swarmed to such an extent as to devour all the purslane, when they attacked grape-vines, and as Mr. Thomas Wells, of Manhattan, Kans., informs me, even cut off corn when it was about a foot high. These worms

Fig. 108.—White-lined Morning Sphinx. (After Riley.)

were the variable larvæ of the White-lined Morning Sphinx, a pretty moth often seen hovering over flowers at evening. Most insects that naturally feed in spring above ground on low vegetation were killed out, and the only species unaffected by the visitation were those feeding on forest trees, or living in the ground or in the trunks of trees. The White-lined Morning Sphinx was just issuing from the pupa, which had remained undisturbed below ground, when the locusts were leaving. It found the purslane—its favorite food-plant—everywhere springing up and abundant, and its eggs were laid without difficulty, and the young larvæ did not in any case lack for food. As a consequence they prevailed to a remarkable degree."

We noticed that timothy and clover were generally ruined in 1875, and had to be replanted; but blue grass did not seem to suffer permanently, but came up again when the insects left. Mr. Boll reports that in Texas a troublesome weed known as broomweed, which ordinarily

covers the prairies, was pretty effectually eradicated in 1877 by the young locusts, which kept the buds eaten out in spring.

The following article, written October 23, 1876, from Yankton, Dak., and published in the *New York Tribune*, gives an interesting summary of the results that followed the defoliation of shrubs and trees in that locality.

Our gardens show some queer effects of grasshoppers which swarmed here in August. Heavy frosts occurred in the last of September, stripping many trees of leaves; but the young fruit-trees, which had every leaf eaten up clean in August by 'hoppers and then put out all the next year's buds, still hold their clusters of rich green, glossy leaves, apparently unconscious of the hard freezes of autumn. While the box-elder, and a few other trees not eaten by them last summer, have shed all their leaves, because ripened to maturity, I find the unripe leaves of the new foliage of the lilac, the egg-plum, the Queen of the Prairie rose, the Hislop and Transcendent crab, and the cottonwood look bright and green and resist the frosts. The Concord grapes are an exception. They were eaten down to mere stubs in August. They budded anew as in spring, grew fast, and produced a good length of young shoots only to wither and be killed by the frosts. One of the queerest effects of the 'hopper pest is this second budding and blossoming of fruit-trees. About October 1, I saw, in my neighbor's garden in this city, a young wild plum-tree bearing a good number of ripe plums, and on every limb were white clusters of blossoms, from next year's fruit-buds, prematurely forced into unnatural bloom by the 'hoppers having taken all the leaves and caused the sap to find a new outlet for its circulation. The flowers were dwarfed and sad-looking, but it remains to be seen what such trees will do next year.

The crab-apple trees at the same time had occasional sprays of blossoms, delicate and sweet as those of May. The insects are very sure to strip these trees, even gnawing off the soft young shoots, but leaving their crop of half-grown fruit to come to a dwarfed and withered maturity in the midst of rich, new foliage as luxuriant as that of early June. But nothing hurts these hardy and valuable trees in Dakota, not even the mysterious fire-blight. I planted some fine young Norway spruces last spring, from a mistaken idea that 'hoppers wouldn't touch evergreens. I have preserved the dry stalk of the largest one, stripped as clean of its bark for some distance as it could have been scraped with a knife. The grasshopper did it with his little hatchet. My horticultural experience with 'hoppers convinces me that we can raise the Miner plum in Dakota unhurt by them; also the Early Richmond cherry. These trees held their leaves intact, while myriads of gnawing pests ate the gooseberry and currant bushes clean—the latter sort mostly dying out, while the gooseberry bushes are again full of foliage and growing as gaily as if we had not had ground recently frozen half an inch thick. Strawberries also did not seem to lose a leaf, while onions were eaten down into the ground.

INJURY TO FRUIT AND FRUIT-TREES.

"It is doubtful if grain-growers and stock-raisers suffer as much in the end as fruit-growers from locust injuries. The injury is at first less felt by these, but in many instances it is more lasting and serious. Most trees survive one or two defoliations, but in many cases no leaves are permitted to grow for weeks, just at the season when they are most needed. This was especially the case in 1875 with low shrubs, such as gooseberries and currants, in which the insects were fond of roosting. Where not excessively numerous, heart-cherries were preferred over others, and the insects would pass through a strawberry bed and only clean out the weeds. A great many trees were killed outright, and it

was often found necessary to cut down the grape-vines. Trees not killed were often badly barked and lost many limbs, and, except where protected by ditches, no orchards yielded fruit." Many trees put forth a few secondary blossoms after the insects left, and some even produced small secondary fruit. The permanent injury becomes more noticeable the succeeding year, for not only do many of the trees die outright, but they are all feeble and more liable than usual to the attacks of the Flat-headed borer (*Chrysobothris femorata*) and other injurious insects.

CHAPTER XVII.

USES TO WHICH LOCUSTS MAY BE PUT.

Locusts may be put to several uses, as food, fish-bait, manure, etc., while, as shown by Professor Kedzie, formic acid, which is used in medicine and may be used in the arts, may be extracted from them. Millions of the inhabitants of Africa and Asia have for ages used locusts as an article of food, and in certain tracts of Africa the advent of swarms of locusts is hailed with joy by the natives (who, it may be remarked, are not farmers), since they afford them an abundant and nutritious article of food. It is well known that the Indians of the Great Basin, or region between the plains and Sierra Nevada, eat locusts and crickets, baking them in holes in which heated stones are placed, and then covering them with soil.

Apropos of locusts as an article of food, we may quote as follows from Mr. Packard's Half Hours with Insects:

> The crustacea afford us the northern lobster, the spiny lobster of the tropics, and numerous kinds of shrimps and crabs, many choice bits for our larder. Whether, however, any of the insects, or their allies the spiders, or even the worms, will ever afford food to civilized man is a matter of grave doubt. While the bulk of our animal food is given us by the vertebrated animals, the ox, sheep, fowl, and game being our main dependence, the mollusks afford us the delicious oyster, which we shall never be able to give up; the less aristocratic clam, handed over to the Pilgrim Fathers by the sagamores and their followers; the delicious though rare scallop and the quahaug, while mussels, snails, and whelks regale our transatlantic friends. Honey is universally sought, and that is an insect product, but the flesh of insects is, upon the whole, repugnant to our feelings. This is certainly unreasonable, for multitudes of the locust or grasshopper of the East are eaten by Arabs and the savages in other parts of Africa. We look with repugnance upon a roasted grasshopper, but an Arab is said to have expressed his abhorrence at our eating raw oysters. While in their sudden flights the grasshoppers cover the ground and eat up every green thing, the natives adopt the sensible course of devouring them in turn. The Bushman, who is no farmer, sings—
>
> "Yea, even the wasting locust swarm,
> Which mighty nations dread,
> To me nor terror brings nor harm—
> I make of them my bread."

He collects them, according to Anderson, by lighting large fires directly in the path of their swarms. As the insects pass over the flames, their wings are scorched and

they fall helplessly to the ground. They are also, he says, collected by cart-loads when they have retired to rest. The locusts, after being partially roasted, are eaten fresh, or they are dried in the hot ashes, and then stored away for future emergencies. The natives reduce them also to powder, or meal, by means of two stones or a wooden mortar, which powder, when mixed with water, produces a kind of soup or stirabout. I have tasted locusts prepared in various ways, but I cannot say that I have found them very palatable. But they must contain a vast deal of nourishment, since the poor people thrive wonderfully on them.

The writer has found by experience that grasshoppers fried in butter taste no better and no worse than shrimps. But the most conclusive evidence on this point are the experiments of Mr. Riley, which we extract in full from his Eighth Annual Report on the Insects of Missouri (1875):

Our relish or disrelish of certain animals for food are very much matters of habit or fashion, for we esteem many things to-day which our forefathers considered either poisonous or repulsive. There is nothing very attractive about such cold-blooded animals as turtles, frogs, oysters, clams, crabs, lobsters, prawns, shrimps, periwinkles, snails, mussels, quahaugs, or scallops until we have become accustomed to them; and what is there about a dish of locusts, well served up, more repulsive than about a lot of shrimps? for the former feed on green vegetation, and are more cleanly than either pigs or chickens. Who can doubt but that the French, during the late investment of Paris, would have looked upon a swarm of these locusts as a manna-like blessing from Heaven, and would have much preferred them to stewed rat? And why should the people of the West, when rendered destitute and foodless by these insects, not make the best of the circumstances and guard against famine by utilizing them as food? Having, in 1875, personally tested them for this purpose, I will here record the result very much as originally given to the American Association for the Advancement of Science at its meeting for that year.

In the few words I have to communicate under this head it is not my purpose to inflict a long dissertation on edible insects. The subject has been sufficiently treated of by various authors, and especially by Kirby and Spence, in their admirable introduction to Entomology; while Mr. W. R. Gerard has brought together most of the facts in a paper entitled "Entomophagy," read before the Poughkeepsie Society of Natural History. It is my desire rather to demonstrate the availability of locusts as food for man, and their value as such whenever, as not infrequently happens, they deprive him of all other sources of nourishment.

With the exception of locusts, most other insects that have been used as food for man are obtained in small quantities, and their use is more a matter of curiosity than of interest. They have been employed either by exceptional individuals with perverted tastes, or else as dainty tit-bits to tickle some abnormal and epicurean palate. Not so with locusts, which have from time immemorial formed a staple article of diet with many people, and are used to-day in large quantities in many parts of the globe.

Any one at all familiar with the treasures on exhibition at the British Museum must have noticed among its Nineveh sculptures one in which men are represented carrying different kinds of meat to some festival, and among them some who carry long sticks to which are tied locusts, thus indicating that in those early days locusts were sufficiently esteemed to make part of a public feast. They are counted among the "clean meats" in Leviticus (xi, 22), and are referred to in other parts of the Bible as food for man. In most parts of Europe, Asia, and Africa subject to locust ravages these insects have been and are yet extensively used as food. Herodotus mentions a tribe of Ethiopians "which fed on locusts which came in swarms from the southern and unknown districts," and Livingstone has made us familiar with the fact that the locust-feeding custom prevails among many African tribes. Indeed, some tribes have been called *Acridophagi*, from the almost exclusive preference they give to this diet. We have it

from Pliny that locusts were in high esteem among the Parthians, and the records of their use in ancient times, as food, in Southern Europe and Asia are abundant. This use continues in those parts of the world until the present day.

In Morocco (as I am informed by Mr. Trovey Blackmore, of London, who has spent some time in that country) they do more or less damage every year, and are used extensively for food whenever they so abound as to diminish the ordinary food-supply; while they are habitually roasted for eating and brought into Tangier and other towns by the country-people and sold in the market-places and on the streets. The Jews, who form a large portion of the population, collect the females only for this purpose, having an idea that the male is unclean, but that under the body of the female there are some Hebrew characters which make them lawful food. In reality there are, under the thorax, certain dark markings, the species used being the *Acridium peregrinum*, which is so injurious to crops. Radoszkowski, president of the Russian Entomological Society, tells me that they are also to this day extensively used as food in Southern Russia, while many of our North American Indian tribes, and notably the Snake and Digger Indians of California, are known to feed upon them. No further evidence need be cited to prove the present extensive use of these insects as articles of food. Let us then briefly consider the nature of this locust food, and the different methods of preparing it.

The records show us that in ancient times these insects were cooked in a variety of ways. *Œdipoda migratoria* and *Acridium peregrinum*, which are the more common devastating locusts of the Old World, are both of large size, and they are generally prepared by first detaching the legs and wings. The bodies are then boiled, roasted, stewed, fried, or broiled. The Romans are said to have used them by carefully roasting them to a bright golden yellow. At the present day, in most parts of Africa, and especially in Russia, they are either salted or smoked like red herrings. Chevier, in his account of the Empire of Morocco (London, 1788), says that thus cured they are brought into the market in prodigious quantities, but that they have "an oily and rancid taste, which habit only can render agreeable." The Moors use them, to the present day, in the manner described by Jackson in his "Travels in Morocco," viz, by first boiling and then frying them; but the Jews in that country, more provident than the Moors, salt them and keep them for using with the dish called *dafina*, which forms the Saturday's dinner of the Jewish population. The dish is made by placing meat, fish, eggs, tomatoes, in fact almost anything edible, in a jar, which is placed in the oven on Friday night, and taken out hot on the Sabbath, so that the people get a hot meal without the sin of lighting a fire on that day. In the Abbé Godard's "*Description et Histoire de Maroc*" (Paris, 1860), he tells us that "they are placed in bags, salted, and either baked or boiled. They are then dried on the terraced roofs of the houses. Fried in oil, they are not bad." Some of our Indians collect locusts by lighting fires in the direct path of the devouring swarms. In roasting, the wings and legs crisp up and are separated; the bodies are then eaten fresh, or dried in hot ashes and put away for future use. Our Digger Indians roast them and grind or pound them to a kind of flour, which they mix with pounded acorns, or with berries, make into cakes, and dry in the sun for future use.

The species employed by the ancients were doubtless the same as those employed at the present day in the East, viz, the two already mentioned, and, to a less degree, the smaller *Caloptenus italicus*. We have no records of any extended use of our own Rocky Mountain species (*Caloptenus spretus*), unless—which is not improbable—the species employed by the Indians on the Pacific coast should prove to be the same, or a geographical race of the same.

It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire which the recent locust invasions into some of the Mississippi Valley States afforded. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast majority of our people, unaccustomed to anything of the sort, and associating with the word insect or

"bug" everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was, in 1874, brought to the brink of the grave by sheer lack of food, while the Saint Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing, in the spring of 1875.

Whenever the occasion presented, I partook of locusts prepared in different ways, and one day ate of no other kind of food, and must have consumed, in one way or another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon most agreeably surprised to find that the insects were quite palatable in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insect is agreeable and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that they need no elaborate preparation or seasoning, and that they really require no disguise; and herein lies their value in exceptional emergencies, for when people are driven to the point of starvation by these ravenous pests, it follows that all other food is scarce or unattainable. A broth, made by boiling the unfledged *Calopteni* for two hours in the proper quantity of water, and seasoned with nothing but pepper and salt, is quite palatable and scarcely to be distinguished from beef-broth, though it has a slight flavor peculiar to it and not easy to be described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage, and other spices *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, they are by no means unpleasant eating and have quite a nutty flavor. In fact it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into soup or broth, for I found the chitinous covering and corneous parts, especially the spines on the tibiæ, dry and chippy, and somewhat irritating to the throat. This objection would not apply with the same force to the mature individuals, especially of the larger species, where the heads, legs, and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled and afterward stewed with a few vegetables and a little butter, pepper, salt, and vinegar, made an excellent fricassée. * * *

I sent a bushel of the scalded insects to Mr. John Bonnet, one of the oldest and best known caterers of Saint Louis. Master of the mysteries of the cuisine, he made a soup which was really delicious, and was so pronounced by dozens of prominent Saint Louisians who tried it. Shaw, in his *Travels in Barbary* (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like craw-fish; and Mr. Bonnet declared that this locust soup reminded him of nothing so much as craw-fish *bisque*, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could only get the insects. His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper, and grated nutmeg, the whole being occasionally stirred. When cooked, they are pounded in a mortar with bread fried brown, or a *purée* of rice. They are then replaced in the saucepan and thickened to a broth by placing on the warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few croutons are added. I carried a small box of fried ones to Europe, where they were tasted by numerous persons, including members of the London Entomological Society and of the Société Entomologique de France. Without exception, they were pronounced far better than was expected, and those fried in their own oil, with a little salt, remained good and fresh for several months; others fried in butter became slightly rancid—a fault of the butter. Mr. C. Horne, F. Z. S., writing to *Science Gos-*

sip, says: "In the evening I had asked two gentlemen to dinner, and gave them a curry and croquette of locusts. They passed for Cabul shrimps, which in flavor they very much resembled; but the cook having inadvertently left a hind leg in a croquette, they were found out, to the infinite disgust of one of the party and the amusement of the other."

* * * * * * *

Locusts will hardly come into general use for food, except where they are annually abundant, and our Western farmers, who occasionally suffer from them, will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies becomes at times most offensive, they find little that is attractive in the pests. For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a strong and not overpleasant odor; but rinsed and scalded, they turn a brownish-red, look much more inviting, and give no disagreeable smell.

Fish-bait has been prepared for the sardine-fishery on the coast of Spain, as may be seen in the following extract from Mr. Packard's report:

It is stated in the *Bulletin Mensuel de la Société d'Acclimation* (August, 1875) that Dr. Morran, a physician at Douarnenez, in Finistère, has thought of utilizing the African locust as bait for the sardine-fishery in the maritime districts of the coast of Manche and the Atlantic Ocean. The doctor hopes to substitute this new bait for that employed until now under the name of roe (rogue), and the price of which, always increasing, is injurious to the interests of French fishermen. The locusts cooked in salt water are dried in the sun, and ground. The powder obtained seems to make as good bait as roe. It has a dark color like that of the pickled roe of Norway. It preserves all the nutritive qualities of the locust. It reabsorbs the pickle, and is fatty, unctuous, and soft to the touch. Besides, it falls to the bottom of the water, resembling the flesh of craw-fish, comminuted and dried fish, of which the sardines are very fond. The insect can be put up in different ways, as made into biscuit, pickled, salted, pressed, or dried in the sun. Different methods of preparation have been tried; cooked and salted, the insects can be piled up in cakes, so as to be easily packed and transported. They can also be thrown alive, pell-mell, into brine and pressed. The first of these methods is employed by the Arabs. The Society of Agriculture of Algeria recommends smothering the locusts in sacks, then drying in the sun. The bait prepared in these different modes has been tried at Douarnenez with good results. The sardines bit at them eagerly. It appears that in the bodies of a great number of sardines there have been found on examination the remains of locusts which the fish had swallowed. This last fact, stated officially, has well satisfied the maritime population of Douarnenez.

Should a demand for similar bait arise on the Atlantic or Pacific coast of the United States, large quantities of fish-bait could be prepared by Western farmers in locust-years.

From locusts an important chemical substance used in the arts may be obtained. This is formic acid, a substance characteristic of certain insect-secretions.

Desiring to obtain as complete an analysis as possible of the juices of the locusts, we engaged Mr. Emmet F. Hill, of Spirit Lake, Iowa, to press a sufficient quantity of locusts, and to send the resulting fluid to Prof. W. K. Kedzie, of the State Agricultural College, Manhattan, Kans.,

with whom we had arranged to make an analysis. The following is Professor Kedzie's report:

KANSAS STATE AGRICULTURAL COLLEGE,
CHEMICAL DEPARTMENT, *November* 6, 1877.

DEAR SIR: In the early part of the month of August last I received from Mr. Emmet F. Hill, of Spirit Lake, Dickinson County, Iowa, a two-quart bottle filled with the expressed juice of the Rocky Mountain locust (*Caloptenus spretus*), and at the same time received your letter of August 2, requesting me to make such examination of the product as should be found possible. In a minute account, forwarded me soon after, Mr. Hill states that the bottle of extract sent me was a portion of seven pints of juice obtained from three-eighths of a bushel of the locusts, weighing altogether 25 pounds, by prolonged pressure under an ordinary screw-and-lever cheese-press. The bottle of expressed juice placed in my possession I found upon examination to contain also a considerable quantity of macerated tissue of the locusts, giving the liquid a somewhat viscid character and dark brown-color. Decomposition had so far progressed as to render very rapid work necessary in order to carry out the programme for the investigation which I had proposed. The liquid was markedly alkaline in reaction. Its proximate composition I determined as follows:

	Per cent.
Water	87.083
Oil	.004
Solid organic matter	12.903
Mineral matter (ash)	.010
	100.000

The oil referred to above was obtained by prolonged digestion with sulphuric ether. It is a fine, transparent, reddish-brown oil of very pungent and penetrating odor; and, although probably of little practical importance, is of great interest, considering its origin and properties. I have still to determine its ultimate composition, and for convenience in future reference I will venture to designate it *caloptine*. The ultimate constitution of the ash of this locust-extract I determined as follows:

	Per cent.
Silica	12.100
Sulphuric acid	1.153
Chlorine	1.760
Phosphoric acid	50.713
Lime	13.260
Magnesia	8.511
Potassa	7.420
Soda	5.083

Copper (distinct trace).

The large proportion of phosphates which the above analysis shows in this ash would not be unexpected, considering the nature and voracious habits of this insect. The presence of copper in perceptible traces is also a very interesting feature of the analysis when considered in connection with the fact that this metal has also been discovered in the blood of other animals, particularly of the *Limulus polyphemus*, the ash of whose blood always furnishes a trace of copper.[96] The accidental occurrence of this metal in the present case is entirely precluded by the fact that in the process of carefully expressing the liquid, it came in contact with no metallic surface whatever; possibly excepting the contact of a small portion with the thread of the iron press-screw. Perhaps the most interesting result of this examination, however, was that obtained by the distillation of this locust-extract with strong sulphuric acid. In this experiment 150 cubic centimeters of the decomposing liquid with 75 cubic centimeters of sulphuric acid were distilled at a high temperature, and the product collected through a Liebig's

[96] See Watt's Chemical Dictionary, vol. i, p. 610.

condenser was found to be 145 cubic centimeters of a colorless, limpid solution of formic acid (CH_2O_2) having a specific gravity of 1.0056. Though this acid exists in the red ant (*Formica rufa*), from which it was originally obtained, and in the larvæ of some species of *Bombyx*, we are to understand that in the present instance it is generated by the action of the sulphuric acid upon the decomposing locust-extract. We know that formic acid may be manufactured by similar distillation of a large number of organic materials with sulphuric acid and peroxide of manganese; but in the case of the locust-juice at this stage of decomposition the formic acid passes over with great readiness, and in remarkable quantity and gravity. Formic acid has a present market-value of about 60 cents per ounce. In the form of the free acid, as formic ether and as formates of ammonium, sodium, &c., it has been employed by English practitioners as a therapeutic agent of considerable value. Free formic acid and formate of sodium are frequently employed as laboratory reagents, and are exceedingly useful for their great reducing power upon salts of the noble metals, silver, gold, and platinum. By the use of sodium formate a peculiar form of *platinum black* may be obtained, of great power in inducing combustion. From its reducing property this salt also constitutes a very convenient reagent in blow-pipe analysis. The various uses of formic acid in all these departments are undoubtedly capable of great and valuable extension, should it ever become a common article of manufacture. It is not, therefore, impossible that the very ready preparation of such large quantities of this acid from the *Caloptenus spretus* may be found in time to have a practical bearing should the only satisfactory solution of the locust problem be found to depend on some profitable disposition of the locusts themselves.

Very respectfully, yours,

WILLIAM K. KEDZIE.

Prof. CHARLES V. RILEY,
Chief United States Entomological Commission.

As a manure, it is obvious that wherever locusts occur in destructive numbers, they may be collected by hand or by machines, killed, and buried in trenches or in compost heaps, and thus utilized. Mr. L. S. Burbank, of Woburn, Mass., has suggested that locusts might be collected in large quantities, dried, and sent east, in bales, as food for poultry.

CHAPTER XVIII.

RAVAGES OF OTHER LOCUSTS IN THE UNITED STATES.

RAVAGES OF LOCUSTS THAT ARE OCCASIONALLY MIGRATORY IN THE ATLANTIC STATES.

While this report is essentially devoted to the true, migratory locust west of the Mississippi, it is not only desirable but necessary to draw brief attention to the ravages of other species in various portions of the country. The differences have already been pointed out between the Rocky Mountain Locust, which does not occur east of the Mississippi, and the Red-legged and Lesser species often found with it. We have further seen that the region of country between the Mississippi and the Rocky Mountains, and much of that west of the mountains, is ravaged by the longer-winged species alone (*spretus*), and it becomes us to ac-

count for the ravages of migratory locusts in the Atlantic States, since swarms have been known in that section of the country to fly from locality to locality, doing immense damage.

We know that migratory locusts do commit sad havoc in the Eastern States from time to time, and are so effectual in their work of destruction that many persons are led to suppose that the Rocky Mountain species has suddenly found its way among them. Among the earlier accounts of the flights and ravages of migratory locusts in this section of country, we find in Harris's Treatise on Injurious Insects an extract from the travels of President Dwight, wherein "they are recorded as being most destructive in Vermont in 1797 and 1798, and as collecting in clouds, rising in the air and taking extensive flights—even covering persons employed in raising a church steeple, who, in such position, saw the insects flying far above their heads." He also quotes from Williamson's History of Maine, that, in 1749 and 1754, they were very numerous and voracious; that, "in 1743 and 1756, they covered the whole country and threatened to devour everything green." In 1874, among other communications, we received the following, descriptive of locust ravages in New Hampshire:

DEAR SIR: I see a note in the *New York Tribune* requesting those from the locust regions to send you specimens of the variety. I send you a vial of them to-day by mail. They have been quite plenty in the Merrimack Valley on some farms—they have eaten all of our garden vegetables; in others they left us a small share. The small ones are the most plenty and the ones that have done the most mischief. I should like to know if they are of the same variety that infested the West.

Yours, truly, LEWIS COLBY.

BOSCAWEN, MERRIMAC COUNTY, NEW HAMPSHIRE, *September* 17, 1874.

The following account of a visitation of these locusts in Cumberland County, Maine, in 1821, by Dr. U. T. True, is so circumstantial that it is given in full, as quoted by Mr. S. H. Scudder:[97]

During the haying season the weather was dry and hot, and these hungry locusts stripped the leaves from the clover and herds-grass, leaving nothing but the naked stems. In consequence, the hay-crop was seriously diminished in value. So ravenous had they become that they would attack clover, eating it into shreds. Rake and pitch-fork handles, made of white ash, and worn to a glossy smoothness by use, would be found nibbled over by them if left within their reach.

As soon as the hay was cut and they had eaten every living thing, they removed to the adjacent crops of grain, completely stripping the leaves; climbing the naked stalks, they would eat off the stems of wheat and rye just below the head, and leave them to drop to the ground. I well remember assisting in sweeping a large cord over the heads of wheat after dark, causing the insects to drop to the ground, where most of them would remain during the night. During harvest-time it was my painful duty, with a younger brother, to pick up the fallen wheat-heads for threshing; they amounted to several bushels.

Their next attack was upon the Indian corn and potatoes. They stripped the leaves and ate out the silk from the corn, so that it was rare to harvest a full ear. Among forty or fifty bushels of corn spread out in the corn-room, not an ear could be found not mottled with detached kernels.

While these insects were more than usually abundant in the town generally, it was

[97] Hayden's Report on the Geological Survey of Nebraska; and "The Distribution of Insects in New Hampshire," p. 375.

in the field I have described that they appeared in the greatest intensity. After they had stripped everything from the field, they began to emigrate in countless numbers. They crossed the highway and attacked the vegetable garden. I remember the curious appearance of a large, flourishing bed of red onions, whose tops they first literally ate up, and, not content with that, devoured the interior of the bulbs, leaving the dry external covering in place. The provident care of my mother, who covered the bed with chaff from the stable-floor, did not save them, while she was complimented the next year for so successfully sowing the garden down to grass. The leaves were stripped from the apple trees. They entered the house in swarms, reminding one of the locusts of Egypt; and, as we walked, they would rise in countless numbers and fly away in clouds.

As the nights grew cooler, they collected on the spruce and hemlock stumps and log fences, completely covering them, eating the moss and decomposed surface of the wood, and leaving the surface clean and new. They would perch on the west side of a stump, where they could feel the warmth of the sun, and work around to the east side in the morning as the sun reappeared. The foot-paths in the fields were literally covered with their excrements.

During the latter part of August and the first of September, when the air was still dry, and for several days in succession a high wind prevailed from the northwest, the locusts frequently rose in the air to an immense height. By looking up at the sky in the middle of a clear day, as nearly as possible in the direction of the sun, one may descry a locust at a great height. These insects could thus be seen in swarms, appearing like so many thistle-blows as they expanded their wings and were borne along toward the sea before the wind; myriads of them were drowned in Casco Bay, and I remember hearing that they frequently dropped on the decks of coasting vessels. Cart-loads of dead bodies remained in the fields, forming in spots a tolerable coating of manure.

In the report of the Connecticut State Board of Agriculture for 1872, page 363, Mr. Sidney I. Smith states that he has seen "hackmatack trees almost covered with them, and entirely stripped of their leaves."

In 1875 they were reported very injurious in Massachusetts, as the following items will show:

Grasshoppers in Boston.—We did not anticipate that Boston proper would ever be so inconvenienced by the pests which have proved so destructive out West, but it is a fact that grasshoppers are so numerous at the south end that they destroy the flowers in the back yards to such an extent that hens are hired or bought to clear the premises and save the ornamental plants which adorn the premises. These insects are not of the Western pattern, but are native productions. If their ravages continue, it is possible some of our Western friends will be called upon to raise subscriptions for the relief of the floriculturists of Boston.—[*Boston Journal.*

I venture to ask your advice in a grasshopper matter. Three years ago a party of farmers and others in this commonwealth, tired of granite hills, gravel banks, and sand flats, and wishing some little latent fertility in the original soil, combined to effect, and did effect, the reclamation from the sea of about 1,400 acres of what originally was "salt marsh." We are amply satisfied of the fertility of this land, and, so far, all is good. Last summer, however, this land and the adjoining territory was scourged with a plague of locusts or grasshoppers. Whether they came in such numbers owing to the diking of these 1,400 acres, or whether they would, last year, have come in equal numbers whether the marsh was diked or not, we cannot say. Our question is this, and is at the same time the point upon which we pray your advice: Can we do anything to diminish the number of these pests for next year? We could, for example, flood this whole tract of land until early spring. Would this be advisable? Any points you would be kind enough to give us on the matter would be thankfully received.—[Letter from C. Herschel, Boston, Mass., latter part of October.

All these reports, as we were able to prove by examining specimens, had reference either to the Red-legged (*femur-rubrum*) or the Lesser (*atlanis*) locust, and in no instance was a specimen of the Western *spretus* among them.

In 1875 the State of Illinois was visited by migrating locusts which passed over the central portion of the State, particularly parts of Livingston, McLean, Vermillion, Ford, and Champaign Counties. These flights occurred early in September, though smaller, scattered flights were noticed later in the month. As usual, in this case they were pronounced to be *spretus* by many writers, who jumped at the conclusion without the slightest possible proof. Prominent journals also published the intelligence that the Rocky Mountain locust had actually crossed the Mississippi.

We did not hesitate at the time to announce that the reference of these swarms to the Rocky Mountain locust was an error, and that they consisted of species native to Illinois. The correctness of these opinions was proved by subsequent facts, as the species examined in every case were found to be indigenous. Their flights were irregular and poorly sustained, and nothing was heard of their ravages or of their again taking flight.

On September 15th of that year we received from Mr. H. P. Beach, county judge of Ford County, Illinois, the following letter, inclosing specimens:

About ten days ago myriads of grasshoppers flew southward over town. Many of them came down, evidently unable to keep up the journey. They seemed to be all the way from a hundred feet to a quarter or half a mile high, or perhaps very much higher. In looking up toward the sun, the only way they could be seen, the appearance was much like that of a snow-storm looked at in the same way. We have not heard from them since, and of course can give you no idea whence they come or whither they go.

About the same date (September 16), Mr. B. F. Johnson, Champaign, Ill., correspondent of the *Country Gentleman*, supposing the species to be *spretus*, wrote to that journal as follows:

When first seen, their movements and motions were so unlike what I had conceived their flights to be, that it was not till several disabled or partially exhausted insects had been caught, and their identity with the Kansas species demonstrated, that I was convinced of their true character. I had supposed that these creatures flew in a manner as pigeons and ducks and geese do—straight ahead in a given direction, and with a purpose. On the contrary, every insect seemed to be out on a holiday, and acting independently of all the others. While the vast mass slowly moved south, with an inclination toward the east, there was a constant circular movement of a vast majority of the whole number of individuals. * * * * * When it got noised abroad that they were flying, the fact produced a startling sensation. Would they increase in numbers till the sun was darkened, and then descend and devour up every green thing, and leave eggs for a progeny behind them that would repeat the disaster next summer? These fears were speedily dispelled when their numbers were seen to diminish, and when it was considered that all the grasshoppers which had passed over, did they come down could make but small impression on the ten thousand square miles of corn in Central Illinois.

Careful examination showed these flights in Illinois to be composed of three species, viz, the Red-legged, the Lesser, and the Differential locusts, while not a single specimen of *spretus* was observed. From Mr. D. J. Dunlap, of Champaign, we received a single male *femur-rubrum;* the specimens from Ford County were *atlanis*, while other specimens received from Professor Burrill, of the Industrial University, were *differentialis*. Mr. Thomas also received this last-named species from Norwood, Mercer County. These specimens were all secured from the flying bevies, and the positive statements of the gentlemen securing them place their identity beyond question.

"From these facts it results that two species, viz, *femur-rubrum* and *differentialis*, though normally having no migratory habit, and, as we believe, incapable of extended flights, can actually assist in such flights. That the bulk of these Illinois swarms was composed, however, of *atlanis*, scarcely admits of a doubt. The other two, less able to sustain lengthened flight, would naturally be most near the ground and most often captured; while *Atlanis*, which we now know to occur in this part of the country as well as East, and to often display the migratory habit, would fly higher."

These phenomena, exceptional to Illinois, are readily explained by two facts, which are worthy of mention in this connection: 1st. *C. atlanis* was very common in Missouri even in localities where its occurrence had not been previously observed, and around Carbondale, Ill. Mr. Thomas was not able to find a single typical *femur-rubrum*. 2d. *C. differentialis* was unusually abundant and was reported in great numbers about October 18th of that year by Mr. M. Brinkerhoff, of Onarga, as filling the ground with their eggs. His letter was accompanied by specimens. The following statement by S. Miller, in the *Rural World* of August 14, 1875, refers to this species, and is interesting in this connection:

> While the migrating 'hopper committed such devastation west of us, we here at Bluffton have the native species in immense numbers. A patch of potatoes and some sweet corn seemed in danger of being consumed, when a flock of purple grackles, our crow blackbird, as it is usually called, came to our rescue. The few days that they have visited the patch has thinned out the 'hoppers amazingly. I never before noticed that this bird was so useful in this respect; and as they are plenty, we may expect to be rid of the big gray fellows ('hoppers). They are more than twice the size of the Colorado 'hopper, and are nearly as bad on a crop when plenty. What saved our little crop from utter destruction was an open field of land thickly covered with wild chamomile, upon which they fairly swarmed. On this we saw them as thick as the Colorados in Sedalia or Warrensburg.

The explanation of these exceptional migrations of local species is simple. In the Eastern States we have seen that they occur at intervals, and the above facts show that they may occur in any portions of the country. Indeed, while the local swarms of 1875 were noticed in Illinois, they were not confined to that State, but were also reported in Kentucky. The summers of 1873 and 1874 had been dry and hot, and these favorable conditions to locust development resulted in an undue multi-

plication of native species, which had, in fact, been quite troublesome in 1874. In 1875, myriads were hatched; but a wet spring and summer produced luxuriant vegetation, upon which these armies made at first but little impression. The waning summer found these locusts "in full feather," and the autumn opening with dry weather, which cured the grass, the locusts swarmed in much of the prairie country of Central Illinois. We found them so abundant, in many places in the vicinity of Saint Louis, that several hundred would rise at every step as one walked through a field. Whenever they abound to an unusual degree the migrating instinct is developed in the commoner locusts just as it is under like circumstances in many other insects, as butterflies and beetles, that are normally non-migratory. But mere increase in numbers would not give to species like *femur-rubrum* and *differentialis*, which are ordinarily heavy-bodied and short-winged, the power of extended flight; and there is little doubt that the same exceptionally hot, dry seasons which permit this undue multiplication also modify the individuals, and cause a decrease in bulk and increase in wing-power. This view is supported by facts, as specimens of *differentialis* from Kansas and Minnesota, upon comparison with normal specimens as they are found in our gardens, can hardly be recognized as the same species, so greatly do they differ. The flying specimens of this species that went to make up the Illinois swarms, also had the body lighter and the wings longer, "and some of that peculiar fierce appearance belonging to migrating specimens," to use Mr. Thomas's language. We know that plants are modified in size and habit by changing conditions of season, &c., and the same holds true of insects, though in some groups this susceptibility to modification is more marked than in others. Yet the flight of these species is never so strong nor so long sustained as that of the true migratory species of the Rocky Mountains.

"In short, whenever the climate and conditions in the Mississippi Valley approach those existing in the native home of the Rocky Mountain locust, some of our native species, and especially those nearest akin to it, also approach it in habit. If the climate of Illinois and Missouri were to permanently change in that direction, these species would become permanently modified; but as there is no immediate danger of such a contingency, the Rocky Mountain locust is the only species, here considered, that can properly lay claim to the migratory habit."

Another large species that occasionally acquires the migratory habit is worthy of mention here, particularly as it has a wide range and is common every year over the larger part of the United States. This is *Acridium americanum*, which is figured and described on page 236 (Fig. 6). In 1876, this species was very abundant and in many cases acquired the migratory habit. Dr. S. Miller, of Franklin, Mo., wrote us that swarms passed over parts of Johnson County late in September. The following extracts also refer to this species:

I send you by Mr. Shaw a small package containing specimens of locusts, destructive about Chattanooga and in all Eastern Tennessee. They strike me as nearly allied

to the Rocky Mountain locust; fly with the same noise and shine of wings, in large shoals, but are larger.—[Dr. G. Engelmann, Warm Springs, N. C., August 29, 1876.

We have a locust here which has in some places occurred in considerable numbers, and some people think it the same as the one which has produced so much damage in the West. This I doubt, as it is evidently a native species.—[E. M. Pendleton, professor of agriculture, University of Georgia, Atlanta, Ga., September 14, 1876.

The American Acridium visited us on the night of November 21 (Saturday). A rain fell during the night. Cambridge City, Ind., was also visited by them on the same night.—[Herschel I. Fisher, Earlham College, Richmond, Ind., 1876.

Acridium americanum.—Two correspondents of the Department of Agriculture, writing from Vevay, Ind., about the middle of last November, reported the visitation in that place of an immense cloud of grasshoppers that literally covered the streets of the town. One of the gentlemen observed, about five p. m., dense cumulo-stratus clouds in the southwest, gradually overspreading the sky; at six o'clock the wind had risen to moderate gusts, and within half an hour a rattling noise was heard against the windows, like that of light hail. On opening the doors, grasshoppers entered in immense numbers, covering the floor, furniture, clothing, &c. The shower continued till eight o'clock, p. m., when the ground was thickly covered, and the boys began to burn them, shovelling them into bonfires.—[*Field and Forest*, February, 1877.

The next two items are from the *Cincinnati Gazette*, of October 24, 1876, and refer to the appearance of this species in Dayton and Hamilton, Ohio.

A shower of mammoth grasshoppers came down upon our town and vicinity on Saturday night. We have never seen such large ones before, and we understand from old citizens that they are entire strangers in this part of the country. We saw a boy have a string tied to two of them (which were as long as a man's finger) trying to drive them, and he succeeded pretty well.

A flock of grasshoppers alighted in Hamilton, about 11 o'clock on Saturday night, from the northwest. Those that were not drowned in the river or killed by the heavy rain, were probably gobbled up before Sunday night by the chickens.

This same swarm passed over Oxford, in the same State, in a southwesterly direction, specimens of the insects composing it, which proved to be the species in question, having been kindly sent to us by Rev. L. L. Langstroth, the well-known apiarian. It is a little singular that previous to 1876 we have but one instance on record of this species becoming so abundant as to seriously injure crops, and that in a locality in Virginia two years previous, while in the season quoted it was reported East and West, and even as far South as Georgia; for toward the end of July the unfledged insects did an immense amount of damage to the cotton and other crops of that State and of South Carolina. The papers were full of graphic accounts of their destruction, and not only did editors very generally take for granted that they had to do with the Western *spretus*, but specimens which Mr. T. P. Janes, Commissioner of Agriculture for Georgia, sent us at once revealed their true character.

There is a serious difficulty in the way of a proper apprehension of the facts in regard to these locust-flights east of the Mississippi, in the failure, in the popular mind, to discriminate between species; the ordinary appellation of *the* locust or *the* grasshopper being applied without

discrimination to any insect of the group that happens to become unpleasantly numerous in any locality. The following item, reported in the *Cincinnati Gazette* of the 24th of October, 1876, from Dayton, Ohio, and referring in reality to the American Acridium, may be cited in illustration:

> The advent of Kansas grasshoppers, over Sunday and until Monday evening, in great numbers throughout the city, is a most remarkable incident. They were found early Sunday morning, and left as suddenly as they came on Monday evening.

Such reports are well calculated to mislead, by confirming the unscientific in the belief that the "Kansas grasshopper" has overstepped the eastern limits which, in Chapter VII, we have been at some pains to define. Even one of the governors present at the conference at Omaha was fully imbued with the idea that the Rocky Mountain pest had come all the way from Asia.

"To the unscientific mind there are few things more difficult of apprehension than that species, whether of plants or animals, should be limited in geographical range to areas not separated from the rest of the country by any very marked barriers or by visible demarkations. Yet such is the fact, known to every naturalist, and the geographical distribution of species forms at once one of the most interesting and one of the most important studies in natural history. Some species have a very limited, others a very wide range; and while, in the course of time, in the lapse of centuries or ages, the limits have altered in the past and will alter in the future, they are, for all practical purposes, permanent in present time. These limits may, in fact, for the purpose of illustration, be likened to those which separate different nations. Though frequently divided by purely imaginary lines, the nations of Europe, with their peculiar customs and languages, are well defined. Along the borders where two nations join there is sometimes more or less commingling; at other times the line of demarkation is abrupt, and in no case could emigrants from the one long perpetuate their peculiarities unchanged in the midst of the other. Yet in the battle of nations the lines have changed, and the map of Europe has often been remodeled. So it is with species. On the borders of the areas not abruptly defined, to which species are limited, there is more or less modification from the typical characters and habits; while in the struggle of species for supremacy the limits may vary in the course of time. The difference is that the boundaries of nations result from human rather than from natural agencies, while those of species result chiefly from the latter, and are, therefore, more permanent. These remarks apply, of course, to species in a natural state, and where their range is uninfluenced either directly or indirectly by civilized man."

We hope that the full definition of the species most closely allied to the Rocky Mountain pest, and the facts as to the home and geographical range of this last, which we have given in Chapters V and VI, will tend to set the public mind right on this interesting subject, be-

cause a good deal of unnecessary alarm is often occasioned by the confounding of species.

THE MIGRATORY LOCUSTS OF THE PACIFIC.

California has, especially in former years, had its locust plague; but since 1855 there has been no general destruction committed. In the last century, according to an article by Mr. A. S. Taylor, in the Smithsonian Report for 1858, they appeared in the following years: 1722, 1746–1749, 1753 and 1754, 1765–1767. In the present century they have appeared in the following years, according to the same authority:

1823.—"Since 1823 the grasshoppers have several times ravaged the fields and gardens of the Franciscan Missions of Upper California."

1827 or 1828.—"About the year 1827 or 1828 they ate up nearly all the growing crops and occasioned a great scarcity of wholesome food."

1834 or 1835.—"About 1834–'35 occurred another visitation of the grasshopper, when they destroyed, a second time, the crops of the rancheros and missions, with the exception of the wheat."

1838–1840.—"Crops and gardens about San Francisco and San Rafael were destroyed." In these districts they stopped for three successive years.

1846.—"Corn and frijoles were completely consumed this year on the Salinas Plains." This was a dry year in California.

1852.—"Some time during the months of June and July the 'hoppers came from a range of rolling hills, some four miles from here, arising from the salt marsh on the east side of the Bay of San Francisco. The grasshoppers have been noticed in the same locality every year since 1852, but not in large numbers."—[Lorenzo G. Yates, Centreville, Alameda County, California, October 17, 1877.

1855.—This year is noted for the prevalence of destructive locusts on the Pacific coast. Taylor remarks that "the summer of 1855, and up to the 31st of October, was the direst which has been known for ten years." They were most abundant from July 15 till September 20.

The Shasta *Courier*, printed in the Northern Sacramento Mountains, remarks that "on Wednesday last (19th September, 1855) an immense flight of grasshoppers passed over this place, flying westward. The greater portion of them flew very high, and could only be seen by shading the eyes from the sun. They were as thick in the heavens as flakes of snow in a snow-storm. We hope they will not stop flying until they reach the Pacific." We find, also, in the accounts of the press of Humboldt and Klamath Counties, that about this time locusts visited the valleys of that part of the country. The Oregon and Washington Territory papers also notice that in the first week of September of that year the grasshoppers were becoming more numerous than ever in their valleys, and doing great damage.

Again:

. The grasshoppers appeared in 1855 in much larger numbers in the valley of the Sacramento and the mountains which bound it on the eastern or Sierra Nevada side than

in any other part of California. * * * In the southern coast counties they were comparatively few in number and did very little injury. They were more troublesome around Los Angeles than anywhere else in the south.—[Furnished by the Smithsonian Institution.

The Sacramento Union, of September 19, 1855, states that the "most remarkable circumstance we have ever been called on to notice in this locality was the flight of the grasshoppers on Saturday and yesterday. For about three hours in the middle of the day the air, at an elevation of about 200 feet, was literally thick with them, flying in the direction of Yolo. They could be the more readily perceived by looking in the direction of the sun. Great numbers fell upon the streets on Saturday, absolutely taking the city by storm, and yesterday they commenced the wholesale destruction of everything green in the gardens of the neighborhood. Their flight, *en masse*, resembled a thick snow-storm, and their depredations the sweep of a scythe."

The Sacramento Valley papers mention that whole orchards, gardens, and vineyards have been consumed by them. Entire fields of young grain, of crops, and vegetables have been eaten up within the space of a single day, leaving the ground like a wilted, blackened desert. In some parts of the valley they annoyed the passengers and horses of the public stages to such an extent as to cause the greatest inconvenience, and appear, in some cases, to have positively endangered human life.

Regarding this 1855 invasion we have further received the following account from Mr. J. W. A. Wright, of Sacramento, who obtained his information from Mr. William Johnston, of Richland, Cal.: "About the middle of June, 1855, the swarms, like clouds darkening the sun, on the first day came from the east and passed over to the west, into Yolo and other counties on the west side of the Sacramento River. The day was clear and warm, not very windy, there being a gentle south breeze. The swarms would rise and fly every few hundred yards. In crossing the Sacramento River they rose higher, perhaps three hundred yards up; immense numbers fell into the river. I heard of them all up and down the Sacramento River. They remained about two weeks in the county and then gradually disappeared. About one-fourth of the crops of Sacramento County were destroyed; everything green was devoured, especially fruit and fruit-trees, ripe wheat and barley suffering but little. Since then Sacramento Valley has occasionally suffered a little from the same species of locust, which was light brown and about one and a half inches long." As this swarm came about the middle of June there is no probability that it was *Caloptenus spretus*, as, if the Rocky Mountain locust should succeed in crossing the desert of Nevada and Oregon into California from its home in the Snake River Valley, about Boise City, it would not reach Shasta or the Sacramento Valley before the last of July or the early part of August. It is most probable that the species was either *Caloptenus femur-rubrum* or *C. atlanis*, which had bred among the western foothills of the Sierra Nevada or the plains lying at

their feet. We have still to learn the date when these two species become winged in California.

Another account of the locust visitation in 1855 in Sacramento Valley has been sent us by an eye-witness, Mr. George Rich, who writes us as follows, January 1, 1878: "About the middle of July, 1855, they came in immense numbers from a southern direction, the wind being south, passing over the Sacramento plains in a northward direction, destroying every green thing as they passed. Touching the foothills, they covered their sides in multitudes, devastating its surface by gnawing the bark of the shrubs, devouring the leaves, and eating the grass even down to the roots. Since 1855 have never seen them in this section." The same writer, in another communication, states that the swarms arrived about midday (July 15, 1855), covering the ground and filling the air probably half a mile high, taking their departure in the evening of the same day. Vegetables and fruit suffered most, though no crop was exempt from their ravages. With the exception of aid from turkeys, nothing was done to destroy them or to protect crops.

1856.—This year, Mr. G. Rich writes us, locusts appeared in smaller numbers in Lower California. In Fresno County the grasshoppers were destructive in 1856.—[W. A. Saunders.

Thomas Birmingham of the Big Tree (Mariposa) station, told us that in 1856, or near this year, two swarms of locusts came from the south during a period covering the months of June and July, into the San Joaquin Valley. They were very abundant, eating grain, vegetables, fruit-trees, even eating a man's coat, and were very annoying to travelers.

1859.—"These insects were first seen by me in Pitt River Valley during the summer of 1859, and in such numbers as actually to cover the ground. So numerous were they that vegetation was entirely destroyed throughout the Valley on the west side of Pitt and Fall Rivers."—[Capt. John Feilner, U. S. A., in the Smith. Rep., 1864.

Mr. George Ohleger of Yuba, Sutter County, writes that "there have been no destructive grasshoppers in this region since 1859; this being in the Sacramento Valley, fifty miles north of the capital."

1862 or 1863.—In Hornitos, Cal., locusts came either in 1862 or 1863, from the south, in June or July, "like a white glistening cloud." They ate the bark of the peach-trees.

1866 or 1867.—In one of these years a swarm extending 15 miles in width was seen at the 15-mile house near Stockton. The insects came from the north, and were so abundant that they filled a well, as our informant (whose name has escaped us) remarked.

1869.—Mr. W. L. Morton of Tulare County, told us that in 1869 locusts were abundant in townships 6, 18 east, and 21, 6 east. They came from the southwest, the last of May till the middle of June, during a period embracing three weeks. They devoured the grapes and leaves of the vines, corn, and wheat.

1873.—"In 1873 they again migrated to Lower California, doing great damage."—[George Rich.

Great ravages were also committed by locusts in Southern California during the same year.—[Riley's 7th Mo. Rept., p. 143.

W. A. Saunders writes from Kingsbury, Fresno County, Cal., that grasshoppers have been abundant and very destructive, but no migrating swarms have been known in the region for the past three years. This is mostly a grazing country, and hay and grain crops suffered severely. Brown "durra" (*Sorghum vulgare*, a kind of millet known as India millet), from its acrid taste while green, is protected from locust ravages to a limited extent. Eggs hatched the present year (1877) early in May, though in previous years they hatched most numerously in June. The insects deposited their eggs about June 21, in "sediment," or sandy soil in dry plains, and fly but little. There have been three very bad locust years, one of which was 1856, though locusts have visited this locality in destructive numbers every year since our correspondent has resided in the locality. The damage for 1877 is estimated at $20,000 in Fresno County. Turkeys and other fowls saved orchards and gardens, and sandhill cranes were of great service, as they are the only kind of bird or fowl that visits that portion of the country during the season the locusts are most abundant.

Mr. Ellwood Cooper, of Santa Barbara, sent us specimens of *Œdipoda atrox* from that locality, in a letter dated July 15, 1877, and says:

> The grasshoppers that have done me so much injury have been produced in this region (the belt of land from Point Conception to Santa Barbara, between the Santa Inez mountains and the ocean), and all of them have been hatched on the table-lands within this scope. The dry year we are now passing through will exterminate them in this region. From the best information I can get, there never were a greater number hatched, but, there being no green food, all died before taking wings.

In an earlier communication, the same writer, states:

> I have inquired as to the extent of the ravages on the plains of Santa Maria, Lompoc, and San Julian, distance 80 to 40 miles. At San Julian I was told they were very numerous, but could not go there to see, nor could I rely upon the information obtained. I will say, however, that at said place the green food always remains at least one month later than in this locality. From Santa Maria, no information; at Lompoc, no grasshoppers were noticed.
>
> They have uniformly appeared from the 1st to the 15th of April. In dry years, when the grasses are short, and in localities where sheep have fed, leaving the ground bare, they appear earlier and in greater numbers. In seasons of abundant late rains, producing rank growth of vegetation, but few, apparently, are hatched. Two of the conditions necessary to hatch all the eggs are bare ground and warm sunlight. I have also observed that where the ground has been bared later than the middle of April, admitting the sun's rays, that very many have been hatched out, but they do not appear to be so strong, neither so destructive. They take wings in about six weeks; are most destructive just after they begin to fly. In their flight, so far as my experience goes, I am led to believe the direction is instinctive, either with or against a strong current of air, to the nearest locality of green food, and in the copulating season to the best locality for the easy deposit of the eggs, and where warm sunlight exposure is certain to hatch them the following year. The time of deposit begins about the middle of June; from this period they do much less injury; do not seem to require food; gather together in bunches on knolls where the earth is loose and the exposure warm.

On these places where they select to deposit their eggs, they are, at times, two and three deep. The depositing grounds comprise a very small surface compared to the whole extent of country in which they exist. Much less than half the number are females or have the power of reproduction. The depositing season lasts two or three weeks, when they disappear and die. I have found on my ranch of 2,000 acres that these beds of deposit do not amount to more than five or six acres. I marked these places so that when the rainy season came I could plow the ground and thus destroy the eggs, and while grasshoppers were produced by the millions on adjoining ranches none were hatched on my place. The conclusion is, that it is not a question to be solved by meteorologists, scientists, or naturalists, but one for the plodding farmer, and that their total destruction is a matter easy, simple, and not expensive. It is a question of the plow—deep and thorough plowing of all the breeding-grounds. This will require a concert of action on the part of the Government of the United States and the governors of all the Western States. Let there be appointed for each Territory five commissioners, and as many for each State, where they have suffered from the ravages of this insect. The duties of these commissioners to solicit information during the coming summer, and wherever they appear to follow them and mark the breeding-spots. In the following spring have every spot well plowed; some kind of crop can be raised that will pay the expense. If this plan is vigorously followed up for a few years, the devastation and misery produced by these insects will be a history of the past.

We have never, heretofore, known positively what species did the injury in California; but the investigations of Mr. Packard on the Pacific coast last year (App. 10, p. 21) render it quite certain that the ravages in California have been committed by the Lesser locust (*C. atlanis*) and the Red-legged locust (*C. femur-rubrum*), which more often acquire the migratory habit than they do on the Atlantic sea-board. The *Œdipoda atrox*, also, as our correspondence shows, is at times exceedingly destructive, but the fact that it perished in quantities last summer during a prolonged and excessive drought that destroyed vegetation would indicate that it must be placed in the same category with the non-migratory locusts of the East, which are also occasionally so destructive; because all the conditions of migration prevailed in Southern California last summer, and if the species possessed the proper wing-power it would certainly have migrated instead of perishing. There is no evidence that the Rocky Mountain locust ever extends west of the Cascade Range northwardly, or of the Sierra Nevada southwardly. The following table will indicate the years during which there have been great locust injuries in some parts of the Pacific coast:

FIG. 109.—ŒDIPODA ATROX.

Tabular view of locust years on the Pacific slope.

IN CALIFORNIA.

1722	1746	1747	1748	1749	1753	1754
1765	1766	1767	1823	1827 or 1828	1834 or 1835	1838
1839	1840	1846	1852	1855	1856	1859
1862 or 1863	1866 or 1867	1869	1873			

IN OREGON, WEST OF CASCADE RANGE.

1852 1855

INJURY FROM OTHER NON-MIGRATORY SPECIES.

Having treated of those locusts that occasionally become migratory both on the Alantic and Pacific slopes, we will close this chapter by considering those locusts which occasionally, from causes already explained, become so numerous as to prove positive pests, and do great injury to crops in different parts of the country. In this category we must include the few common species already mentioned as proving exceptionally migratory, as well as others which, from the shortness of their wings, are incapable of extended flight, and never become migratory. With ever-changing meteorological conditions, nearly every year some portion or portions of the United States become favorable for the undue multiplication of given species, and so, nearly every year, their injuries are reported.

In 1868 indigenous species were extremely injurious. In Ohio they appeared in countless myriads, and at the meeting of the Cincinnati Wine Growers' Society it was stated that they invaded the vineyards, destroying entire rows, defoliating the vines, and sucking out the juices of the berries. They occurred in countless millions in many parts of Illinois and Missouri, and actually stripped many corn-fields in these States, and, had not the crops been unusually abundant, would have caused some suffering. They were also very destructive to flower and vegetable gardens.

In 1869 they were even worse than in 1868. In the vicinity of Saint Louis they were particularly annoying, stripping the tops of Norway Spruce, Balsam Fir, and European Larch, and devouring the blossoms off Lima beans. They severed grape stems and ate numerous holes into apples and peaches, thereby causing them to rot. Their ravages for this season, however, seemed to be confined to the West, as they were more particularly abundant in Illinois, Missouri, Iowa, and Kentucky. During this year locusts attracted little attention in the Eastern States, but two years afterward they did much damage there, as may be seen by the following items :

The grasshoppers (locusts) have been more numerous and destructive this year, in Maine, than perhaps ever before. This was partly owing to the dry weather, and with the advent of the rainy season we hope their career will be somewhat checked. In this county they are thick, but in some of the central portions of the State they

literally swarm, devouring nearly every green thing before them. They did much injury to the grass-fields, and, now that is cut, they have betaken themselves to the cultivated crops. In some cases, whole fields of corn and beans have been completely stripped. Even the potatoes have not been spared.—[*Country Gentleman*, August 10, 1871, speaking of insects in Maine.

Grasshoppers are reported to have very seriously injured the corn, grass, and grain crops (and in some cases orchards and nurseries) of the counties of Androscoggin, Franklin, Knox, Kennebec, Lincoln, Oxford, Piscataquis, Penobscot, Waldo, and Somerset, in Maine. So serious has been the damage that the subject was made a topic at the recent State Agricultural Convention in that State. In Androscoggin County they injured pastures greatly, and affected the condition and price of stock. Some grain-fields were protected by drawing a rope across the heads at sunset, thus brushing off the insects and preventing feeding. In Franklin County, a field of twelve acres of sweet-corn was only saved by keeping a man in it continually to drive out the grasshoppers. One man in York County stopped their passage to his fields by building a brush-fence around them.—[*American Agriculturist*, 1871.

These pests (the locusts) have been numerous and destructive during the past month, in some portions of the Eastern States. In Sagadahoc County, Maine, the crops and pastures were injured by them very much; also in Hancock County. In Franklin, many fields of grain were cut to save the crops from them and for feeding. In Oxford, oats were "eaten entirely down, as clean as though fed upon by sheep." In some portions of Plymouth County, Massachusetts, they are reported to have eaten everything green. In Caledonia County, Vermont, they have been very destructive. All through Windsor they have been "a terrible scourge." In Orleans they are reported abundant, and in Windham they have done "much injury to some of the crops." In Wayne County, Pennsylvania, also, they are reported to have done much damage.—[*Monthly Report, Department of Agriculture*, for August and September, 1871.

In 1872, locusts were again bad in the Eastern States, as will appear by the following from the *Mirror and Farmer* (New Hampshire) for August 10:

The grasshoppers are making great havoc on the grass, grain, and corn. For a space of about one and a half miles square they are destroying almost everything. Clover is trimmed up all but the head; oat-fields look like fields of rushes coming up to the height of sixteen or eighteen inches without leaf or head. The leaves of wheat and their kernels are eaten out. These choppers move back and forth two or three times a day, and whole sections are almost alive with them.

In 1874, they were again troublesome in the Mississippi Valley and at points in the East:

The grasshoppers destroyed four acres of my wheat last fall; ate and destroyed my timothy twice; sowed the ground again this spring, but as there are still plenty of hoppers, there is not much hope for a stand.—[Letter extract from G. Pauls, Eureka, Mo., November 10, 1874.]

Some of our good friends in Suffolk County, Virginia, were unduly excited this summer over the idea that the Western destructive grasshopper, *Caloptenus spretus* of Uhler, had found its way to the "sacred soil of Virginia." There was no denying the fact that myriads of grasshoppers were devouring nearly "every green thing," even settling on the trunks and limbs of trees, and gnawing the bark in a most unkind manner; and, as it appeared to be something altogether foreign to the locality, of course it must be the Western pest. Specimens were forwarded to us, however, and a glance was sufficient to show us there was no need for alarm, as it was quite a common species in this part of the United States, and though rather too plentiful in this particular locality, would not spread or become the terror that its Western distant relative has proved. The insect is known as the *Acridium americanum*, and is of large size, often measuring over two and a half inches in length.—[C. R. Dodge in *Rural Carolinian*, November, 1874.

In 1875, as we have already seen, they were again troublesome in Massachusetts and Illinois, while the August and September issue of the *Monthly Report of the Department of Agriculture* gives a record of their injuries in New Hampshire, Pennsylvania, Virginia, West Virginia, Ohio, Michigan, and Tennessee.

In 1876, locust ravages were again reported in many sections of the country, and the American Acridium was especially observed.

Finally, last year (1877), the destruction of field-crops was extensively reported, particularly in the northern tier of States including New Hampshire, Vermont, New York, and Michigan. Specimens received from various sources showed that the Red-legged and the Lesser locusts were the principal culprits. We quote a few items taken from the many published at the time of injury:

They are having a genuine grasshopper scare in Michigan, and a dispatch to the *New York Herald* of July 6 reports that the pests have destroyed about four thousand acres of grain in Oakland and Ionia Counties, and the farmers are in despair. The grasshoppers are not, however, the genuine Rocky Mountain species, which, as yet, have never crossed the Mississippi River; but they are the common Northern red-legged grasshoppers, which sometimes become so abundant as to do considerable damage to crops. Many of the farmers in the afflicted counties named will, no doubt, believe that the "hatefuls of the far West are upon them, in spite of all the soothing words of entomologists to the contrary.—[*Rural New Yorker* of July 14, 1877.

The grasshoppers have so far destroyed the feed in some pastures near Saint Albans, Vt., that the farmers have been obliged to commence feeding their cattle with hay. Several are mowing their oat-crop for fodder or drying it for winter use. Corn-stalks are eaten off by the pests, and unless wet weather sets in it seems inevitable that they will destroy most of the unharvested crops and the fall feed.—[*Western Farm Journal*, August 17, 1877.

In North Hero, grasshoppers are doing much injury to beans, oats, and buckwheat.—[*Mirror and Farmer*, Manchester, N. H., August 11, 1877.

We are informed by a farmer resident in Northern New York, that the grasshoppers have committed irreparable injury to the growing crops in that section, thus blighting the prospects of a bountiful harvest. They first attacked the grass, and when that was cut they assailed the oats and orchards, utterly ruining them, and are now rapidly destroying the corn and potatoes. There is no barrier to their ravages, and the only hope is in their onward progress. This gentleman thinks that this plague will reach New Hampshire by another year, as it has already appeared in Vermont. The only precaution that can be taken is in the character of the crops, and unfortunately there are few crops they do not assail. Thus far, the growing wheat in Northern New York has been exempt from their ravages.—[*Naskua Telegraph*.

We have seen in the valley of the Merrimack this summer fields in which the grasshoppers had cut the grass as clean and close as a flock of sheep would have done, and fields of beans and oats in which every leaf had been devoured.—[*Mirror and Farmer*, August 18, 1877.

I send you specimens of grasshoppers which are very destructive in this immediate neighborhood the present season.

The pests were first discovered about the 10th of May, on low meadow land subject to overflow. They were at that time not more than one-eighth to one-quarter of an inch long, and then rather of a dark or muddy-green color, a large portion of them changing to a yellow and brown-yellow color as they grew. They are now, a large portion of them, one to two inches long. What are they—the common meadow grasshopper, or a new species?

I want information as to whether the same locality or place is likely to be overrun and eaten by them another year, or for a series of years. They are very numerous; have totally eaten up hundreds of acres of meadow and pasture, and have done considerable damage to corn and oats. They have eaten up eighty acres of meadow for me, so closely that I shall not get one wagon-load of hay. They spread off the low ground, after eating up the grass, to the higher portions of the meadows, and thence to other fields.—[Correspondence of the *Country Gentleman*, Brentsville, Va., July 26, 1877.

"The grasshopper plague, or a modification of it," says the Republican, "has visited Eureka, Mo., and the general impression is that they constitute a detachment of skirmishers from the Nebraska army that has lost itself west of the summit of the Rocky Mountains."—[*Western Farm Journal*, July 15, 1877.

Mr. A. H. Gleason, of Little Sioux, Harrison County, Iowa, sent us (May 21, 1877) the following, with specimens of *Tragocephala viridifasciata* (Fig. 9):

I send you specimens of the white or gray 'hopper. These 'hoppers are always here. They lay their eggs in August or September, and these hatch (at least some of them) the same fall. I saw them last October and November, little fellows in spots of one square yard to a twenty acre piece covering the ground as thick as ever I have seen the Western plague. I have found them early in the winter under the leaves and dry straw and husks that have drifted up under the fences and behind logs in the woods in a dormant state, and upon warming them they would become as brisk as ever. I found them this spring, in April, very big. Many of them are fully developed and are flying around, yet they have never done us any particular damage.

Mr. George Way, writing from Socorro, N. Mex., July 5, 1877, sent us specimens of *C. differentialis* (Figs. 32, 110). He says: "I send you specimens of the only herd of locusts in our county. They were noticed about four weeks ago, and since that time have been living on dahlias and hollyhocks, with very little grass." He also states in this communication that beyond his own yard little injury was done.

FIG. 110.—DIFFERENTIAL LOCUST.

Mr. Arthur P. Gray noticed great numbers of the common Red-legged locust at Kittery, Me., about the middle of August, 1877. In York and Elliot immense quantities of the insect were observed along the road-sides and upon the lower rails of the fences, so thick that in many places the rails were hidden from view.

FIG. 111.—TWO-STRIPED LOCUST.

Theo. M. Finley, writing from Niles, Mich., sent us specimens of *Caloptenus bivittatus* (Fig. 111), with the statement that they did considerable damage near Berrien Springs, Mich., though confined to a territory of only a mile square. Grass and oats suffered most, the last crop being entirely destroyed.

CHAPTER XIX.

RAVAGES OF LOCUSTS IN OTHER COUNTRIES.

CENTRAL AMERICA.

That swarms of locusts have periodically ravaged Mexico at times for over two hundred years, is apparent from the accounts in the works of Thomas Gage and Clavigero, as well as Mr. E. G. Squier and other modern writers. We take the following extract from Gage's New Survey of the West India's:[98]

In the mean time I lived full five years in the two towns of Mixco and Pinola, where I had more occasion to get wealth and money, than ever any that lived there before me; for the first yeer of my abiding there it pleased God to send one of the plagues of Egypt to that Countrey, which was of Locusts, which I had never seen till then. They were after the manner of our Grasshoppers, but somewhat bigger, which did flie about in number so thick and infinite that they did truly cover the face of the Sun and hinder the shining forth of the beams of that bright planet. Where they lighted either upon trees or standing Corn, there nothing was expected but ruine, destruction, and barrennesse; for the corn they devoured, the leaves and fruits of trees they eat and consumed, and hung so thick upon the branches that with their weight they tore them from the body. The high waies were so covered with them that they startled the travelling Mules with their fluttering about their head and feet; my eyes were often struck with their wings as I rid along, and much ado I had to see my way, what with a Montero wherewith I was fain to cover my face, what with the flight of them which were still before my eyes.

The Farmers towards the South Sea Coast cried out for that their Indigo which was then in grasse, was like to be eaten up; from the Ingenio's of Sugar the like moan was made, that the young and tender Sugar Canes would be destroyed; but above all grievous was the husbandmen of the Valley where I lived, who feared that their Corn would in one night be swallowed up by that devouring Legion. The care of the Magistrate was that the Towns of *Indians* should all go out into the fields with Trumpets, and what other instruments they had to make a noise, and so to affright them from those places which were most considerable and profitable to the Common-wealth; and strange it was to see how the loud noise of the *Indians* and sounding of the Trumpets defended some fields from the fear and danger of them. Where they lighted in the Mountains and High wayes, there they left behind them their young ones, which were found creeping upon the ground ready to threaten with a second years plagues if not prevented; wherefore all the Towns were called with Spades, Mattocks, and Shovels to dig long Trenches and therein to bury all the young ones.

Thus, with much trouble to the poor *Indians*, and their great pains (yet after much hurt and losse in many places) was that flying Pestilence chased away out of the Countrey to the South Sea, where it was thought to be consumed by the Ocean, and to have found a grave in the waters, whilst the young ones found it in the Land. Yet they were not all so buried, but that shortly some appeared, which, not being so many in number as before, were with the former diligence soon overcome. But whilst all this feare was, these outcries were made by the Countrey and this diligence performed by the *Indians*, the Priests got well by it; for every where Processions were made, and

[98] A New Survey of the West India's: or the English-American, his Travail by Sea and Land: containing a Journal of Three Thousand and three Hundred miles within the mainland of America, etc., etc. The Second Edition enlarged by the author, and beautified with Maps. By the true and painful endeavours of Thomas Gage, Preacher of the Word of God at Deal, in the County of Kent, London, M.DC.LV. 8°. pp. 220.

Masses sung for the averting of that Plague. In Mixco most of the idols were carryed to the field, especially the pictures of our Lady, and that of St. Nicolas Tolentine, in whose name the Church of *Rome* doth use to blesse little Breads and Wafers with the Saint stamped upon them; which they think are able to defend them from Agues, Plague, Pestilence, Contagion, or any other great and immanent danger. There was scarce any *Spanish* Husbandman who in this occasion came not from the Valley to the Town of Mixco with his offering to this Saint, and who made not a vow to have a Masse sung unto Saint *Nicholas;* they all brought breads to be blessed, and carryed them back to their Farmes, some casting them into their Corn, some burying them in their hedges and fences, strongly trusting in Saint *Nicolas*, that his bread would have power to keep the Locust out of their fields; and so at the last those simple, ignorant and blinded soules, when they saw the Locusts departed and their Corn safe, cried out to our Lady some, others to Saint *Nicolas*, Milagro, a Miracle, judging the Saint worthy of praise more than God, and performing to him their vows of Masses, which in their fear and trouble they had vowed, by which erroneous and Idolatrous devotion of theirs I got that year many more Crowns than what before I have numbred from the Sodalities. The next year following, all that Countrey was generally infected with a kind of contagious sicknesse, almost as infections as the Plague, which they call Tabardillo, and was a Feaver in the very inward parts and bowels, which scarce continued to the seventh day, but commonly took them away from the world to a grave the third or fifth day. The filthy smell and stench which came from them, which lay sick of this disease, was enough to infect the rest of the house, and all that came to see them. It rotted their very mouths and tongues, and made them as black as a coal before they died. Very few *Spaniards* were infected with this Contagion; but the *Indians* generally were taken with it. It was reported to have begun about *Mexico*, and to have spread from Town to Town, till it came to Guatemala, and went on forwards; and so likewise did the Locusts the year before, marching as it were from *Mexico* over all the Countrey.—pp. 163, 164.

The date of this invasion, as near as we can ascertain from the few dates given by the author, was apparently either in 1633 or 1634.

Clavigero (according to A. S. Taylor) witnessed locust invasions in 1738 or 1739 upon the coasts of Xicayan, in Oaxaca. Afterward a famine occurred in Yucatan.

In Wells's Explorations in Honduras, published in New York in 1857, including original observations in the elevated mesas and valleys of Eastern Honduras, the author remarks:

The civil war, in 1853 and 1854, between Honduras and Guatemala, had paralyzed every branch of trade, and the distress thus caused was increased by the scourge of locusts passing in vast clouds over Central America, sweeping away, *as by a conflagration*, every green thing, and leaving famine and desolation in their path. The ravages of the locusts in late years (consuming whole crops of a night) have combined with war, decay of mining enterprises, and political changes to reduce the population of Juticalpa from 8,000 to 4,000 souls.[99]

Regarding the injuries caused by a Guatemalan locust, we quote the following account from the Hon. E. G. Squier's Honduras; Descriptive, Historical, and Statistical, 1870:

The insect, however, which is most dreaded in Honduras, or, indeed, in all Central America, is the *langosta* or *chapulin*, a species of grasshoppers or locust, which at intervals afflicts the entire country, passing from one end to the other in vast columns of many millions, literally darkening the air and destroying every green thing in their course. I once rode through one of these columns, which was fully ten miles in width.

[99] Received from the Smithsonian Institution.

Not only did the insects cover the ground, rising in clouds on each side of the mule-path as I advanced, but the open pine-forest was brown with their myriad bodies, as if the trees had been seared with fire, while the air was filled with them, as it is with falling flakes in a snow-storm. Their course is always from south to north. They make their first appearance as *saltones*, of diminutive size, red bodies, and wingless, when they swarm over the ground like ants. At this time vast numbers of them are killed by the natives, who dig long trenches two or three feet deep and drive the *saltones* into them. Unable to leap out, the trench soon becomes half filled with the young insects, when the earth is shoveled back, and they are thus buried and destroyed. They are often driven in this way into the rivers and drowned. Various expedients are resorted to by the owners of plantations to prevent the passing columns from alighting. Sulphur is burned in the fields, guns are fired, drums beaten, and every mode of making a noise put in requisition for the purpose. In this mode detached plantations are often saved. But, when the columns once alight, no device can avail to rescue them from speedy desolation. In a single hour the largest maize-fields are stripped of their leaves, and only the stems are left to indicate that they once existed.

It is said that the *chapulin* makes its appearance at the ends of periods of about fifty years, and that it then prevails for from five to seven years, when it entirely disappears. But its habits have never been studied with care, and I am unprepared to affirm anything in these respects. Its ordinary size is from two and a half to four inches in length, but it sometimes grows to the length of five inches.

Mr. Taylor remarks that "this statement is consonant with the accounts received from Honduras and Guatemala of the famine and pestilence of fever in those countries in 1855 and 1856, caused by clouds of locusts devastating the country, and confirms Gage's history of the same lands in 1632." In 1855 the valley of Colima, in Southwestern Mexico, was visited by locusts.

In 1856 their ravages extended along the mesas or steppes bordering eastward the Rocky Mountains, covering the dry soils of Texas, and down into the south of Mexico. In the vicinity of Cordova, in the State of Vera Cruz, the people made a regular campaign against them, and succeeded in destroying one hundred and ninety-two arrobas, computed as numbering four hundred million grasshoppers. In the State of Guerrero they also did great injury, particularly within the districts around Acapulco.

We have received from Signor Manuel Medina, of Merida, Yucatan, the following answers to our circular, the numbers corresponding to the numbers appended to the questions in our circular:

1. The swarms of locusts which appeared some nine miles from the sea-shore, were suddenly discovered in June, 1871, in great quantities, living on the leaves of the *Agave sisalense* in plantations covered wholly with this plant. It could not be ascertained whence they came, but surely they began to be noticed by that time not far from the port called Progreso. They began to migrate, flying always toward the south, the wind blowing, from the spot whence they started, in a northeast direction. The temperature was then very warm, say 87° to 90°, the mornings being lightly moist and cloudy, but the rest of the day very clear. The density of the swarms flying when started was not of great consideration, migrating in comparative small portions. They did not invade the whole province, but only a portion of the country from north to south on a breadth of 40 or 60 miles.

2. The date of departure is that of its discovery, when started by the exertions of men, in June. The force of the wind was always not hard, but in a southeast direction. The

temperature always very warm. The time of the day when started by men was in the morning from six o'clock to eight o'clock, and portions were caught and burned in heaps.

3. The eggs, ever since, to the present time, have been deposited, although in a considerable small portion, abandoned as they are on the consideration of not being destructive; since the damage done has not been of much consequence, not even on the Agave leaves which they at first ate but did not kill. They deposit their eggs in summer, say from February to June. At present are very scarce, and the large swarms are not found as in 1871, 1872, 1873, 1874, 1875, and 1876.

4. This year are very scarce.

5. February, 1875.

6. I suppose as the only reason for their scarcity this year the heavy rains that occurred from July to October.

9. August.

11. The injury done as yet is of no consequence, with the exception of some one or other corn-field.

16. The only means employed is that of catching them early in the morning to be burned, or raised up by noise to make them fly away from the spot. In the morning has been more easy to catch them, for they cannot fly. I suppose on account of morning dew.

19. The year 1876 is the last year when numerous swarms have been seen. This year, to the present date, are very few.

20. Never previous to 1871.

21. They have been extensively useful in the destruction of these insects, numerous as our birds are, of all kinds on the fields. As it has been observed that these insects are not so voracious as the Arabian locusts, it is supposed to belong to a kind of grasshopper natural to this country, although these sent now as a sample are larger.

Merida, December 24, 1877.

MANL. MEDINA.

The specimens sent by Signor Medina, and supposed by him to be the same as those destructive in 1871, were sent to Mr. S. H. Scudder for identification, and most of them proved to be *Acrydium americanum*; with these occurred specimens of an unknown species allied to *Acrydium flavofasciatum* De Geer.

We have also received the following account of the locust in Granada, through the kindness of Mr. Flint:

GRANADA, NICARAGUA, *December* 18, 1877.

MY DEAR SIR: Yours of November 26 reached me yesterday, asking for information relative to the locusts that invaded this republic last year.

During a residence of twenty-seven years I have observed but two invasions. The first appeared in 1851, entering at Chinendaga from the northwest point along the coast from Cosaguina. Many falling into the sea were floated ashore and caused a stench for many days along the beach as far down as Escalante. How far inland they reached at that time is not known. They were quite destructive to the crops at that time. I resided at Realjo, and a friend of mine, S. Watts, living near Chinendaga, showed me his corn-field, entirely eaten up in one forenoon. The country was in revolution at the time and little was done to abate their progress. I well remember one day while at Chinendaga—the whole town was in an uproar, beating on drums, tin pans, and every conceivable thing, to prevent their alighting in the neighborhood. They reached the department of Rivas in 1853; their progress is gradually southward; they disappeared in 1854. They were the same as those now devastating Nicaragua.

Appeared in 1876, after an interval of twenty-five years, entering, as before, about

Chinendaga, passing eastward as far as Nagarote, in swarms, and thence along the coast-range, entering the Department of Rivas in June, devastated that department of its crop of indigo, with a very few exceptions. Corn, not well advanced, was in a like manner destroyed, and the second crop nearly one-half. The pastures of Para and Guinea grass when invaded also disappeared. They eat anything that is within their circuit useful to man, except rice and quiquisque. The plantain, on which the poorer class rely as their principal food, they left destitute of leaves. Oranges and cocoanuts were not omitted in their bill of fare; also hedges of mango trees were eaten in certain locations; the cactus hedges, although hard and acrid, were a delicate morsel for them, and many fields were left open to the invasion of cattle and others for their exit.

Was in Rivas 20th day of last July and fore part of August; also from September 12 to December 12. Then the third generation was hatching out. Eggs recently laid were placed in a glass bottle, and in twenty-two days all hatched out, and were quite lively. They lived a few days thus shut up without food. They were more destructive in Rivas than here, as the swarms of the first invaders, after reaching Nagarote, kept down the coast range southerly, leaving in all their course immense swarms, selecting open places, and especially those that were in any way cultivated. These commenced laying, the male remaining attached, until the female deposited all of her eggs, and then dying. Often you see a male alive attached to his dead mate. In twenty-two days the first young appear and attach themselves to any herb or grass that is near. These are the most destructive to agriculturists. A spear of grass, a stalk of corn, an indigo-plant, any plant, is so completely covered that its color is not discernible. They delay three months ere their wings are matured sufficiently to fly well. They then visit the best location, flying in swarms in all conceivable directions; one course to-day and another to-morrow; preparing for the final flight in search of proper hatching ground. Those entering the State last year leaving descendants along their route, appeared here last year too late in June to destroy the first corn-crop, only in certain localities. Their descendants did much damage to other crops of grass, corn, plantains, beans, &c., coming to maturity in the latter part of December and fore part of January, seeking the mountains and forest, and the coast all to the west and south of here, and entering the long stretch of forest between Rivas and Costa Rica, reproducing in these localities during the dry season; few only of those that arrived last year; the first ones reached Costa Rica, and did but little damage in Liberia; but those that incubated in the forest about Rivas and below, migrated to Costa Rica early in June, and have disseminated over the entire State.

So rigorous were the measures adopted by that government that the military refused to comply, and in trying to enforce it the incumbent governor was forced to resign, giving place to Guardia, who revoked them. Have no news from there relative to the destruction caused this year. While there, from April 20 to May 5, saw a large swarm at Siete Cuero, flying east from the coast April 28, 3 p. m. to 5 p. m. On the 1st of May, near the foot of Rincon Mountain, saw another swarm flying west from 11 a. m. to 3 p. m.; both days clear and very hot; the only two seen not very dense; wind northeast, strong.

The means adopted for their destruction when young, was ditching in places most convenient for driving the young, which could not escape, into the trenches, where they died. When in flight each farmer did what he could to prevent their alighting. This in most cases resulted injuriously to his neighbor. A tax of 50 cents, or a day's labor, per capita per month was levied on all men from 18 to 50; this was collected only one month. An old law existed of which I am ignorant—was more onerous. The local authorities of each village compelled the men to work in exterminating the young—generally in ditching, killing many, beating them toward the ditches with brush. In Rivas many were destroyed this year, that department being better adapted for their destruction. Here it is quite difficult—isolated fields alternating with uncultivated spots of wood and brush, making it almost impossible to drive them. Each owner now has, in

most cases, to look out for his own interest, often assisted by his neighbor; thus many have been destroyed. There are many yet in all the department west of Lake Nicaragua, between here and Managua. Quite an abundance of young hatched out in October, not yet able to fly, and too large to drive. They will reach maturity in January, and seek the same haunts as last year; probably will reach farther south. There is a notable diminution from last year.[100] In the dry season, when they commence their flight, innumerable flocks of a bird about the size of a pigeon, dark lead-color, hawk-bill, destroy many; also another, the queque, also consumes great quantities; have not seen them near the city. The head is white, and it is of the size of a buzzard; another name is son-chiche (provincial names). The domestic fowls eat them when accessible; also many birds, not however to the extent of the two first. There is a parasite underneath the wings that destroys many. I observed some last year with a microscope; will try and find some more to remit in the next box of antiquities I send to the Smithsonian Institution. Some full-grown locusts I sent to Professor Henry in June, in a bottle with carbolic acid. They went with the Flint and Bransford Central Railroad collection. My opinion is that they are degenerating, and will disappear[101] next year, with a small effort of the people. It would be well to inquire if they have reached Panama or Cherokee; I think they will not pass below Cherokee.

Some specimens were brought me last evening, all taken from one location; they are of different sizes; some have wings nearly of a full growth. Am waiting their classification from the Smithsonian Institution. Don't think they are *Caloptenus;* they resemble *Œdipoda* of Say; these have spotted elytra wings, and are larger; last ventral segment notched, as in *spretus*. Would observe that many private efforts to exterminate them in certain localities, when young, resulted in the adoption of torches made of strips of cloth dipped in kerosene, used mostly on green cactus hedges. It seems superior to any other.

If any new facts occur, will inform you or Professors Henry or Baird, who can transmit them to the central office. Hoping this may be of use to you, excusing the haste, made to comply promptly for this mail,

I beg leave to remain, yours sincerely,

EARL FLINT.

A. S. PACKARD, JR.,
Secretary United States Entomological Commission, Salem, Mass.

P. S.—Courier says they are abundant in Leon. One square foot of plowed ground contained 28 nests, with from 80 to 84 eggs in each.

THE LOCUSTS OF SOUTH AMERICA.

The treeless portions of South America are also not exempt from swarms of locusts, though we have no information as to the different species composing them. Taylor says that at the time of the visit of Darwin to Chile and the adjacent countries of South America he relates of the grasshoppers as follows, at the date of March 25, 1835, when he was crossing the dry country which lies between the city of Mendoza, in Buenos Ayres, and the opposite side of Chile. This country assimilates in every essential physical characteristic to that of the territories within

[100] Except the district northeast from here, where it seems they are working around the head of the lake—having reached as far as Teustepe. There I am informed, this morning, the 19th, that the region, for miles about that district is covered with young in different stages of development, and that some of the full-grown are leaving for the mountains; thus it is feared that they will get a foothold in the grazing country of Chontales, so well situated for their propagation, and by destroying the pasture, deprive the department of beef. The prefect gave his opinion last evening that we were menaced with a scarcity of food for next year, should they continue. Heretofore they have not passed around the lake.

[101] Unless they gain a foothold in Chontales.

the boundaries of Upper and Lower California prior to the American occupation:

Shortly before arriving at the village and river of Luxan, we observed to the south a ragged cloud of a dark reddish-brown color. At first we thought it was caused by some great fire on the neighboring plains, but we soon found that it was a swarm of locusts. They were flying northward, and with the aid of a light breeze they overtook us at the rate of ten or fifteen miles an hour. The main body filled the air from a height of twenty feet to that, as it appeared, of two or three thousand feet above the ground. The sound of their wings was as the sound of chariots of many horses running to battle; or rather, as I should say, like a strong breeze passing through a ship's rigging. The sky, seen through the advanced guard, appeared like a mezzotinto engraving; but the main body was impervious to sight. They were not, however, so thick together but that they could escape a stick waved backward and forward. When they alighted they were *more numerous than the leaves in the field*, and the surface became reddish instead of green. The swarm having once alighted, the individuals flew from side to side in all directions. Locusts are not an uncommon pest in this country. Already during this season several smaller sw arms had come up from the south, where apparently, as in all other parts of the world, they are bred in the deserts. The poor cottagers in vain attempted, by lighting fires, by shouts, and by waving branches, to arrest the attack. This species of locust closely resembles, and perhaps is identical with, the *Gryllus migratorius* of Syria and Palestine.

The pestilent ravagers named abound in the provinces of the La Plata River, and commit as much havoc as their congeners of Chili and California. Lieut. Archibald McRae, attached to the coast survey of California in 1856, was employed as assistant to Captain Ellis in the United States astronomical expedition to Chili in 1850–'52, and performed a scientific journey from Mendoza to Buenos Ayres, in December, 1852, in connection with the expedition. He mentions having encountered, in that month, immense swarms or "myriads" of locusts on the dry pampas near the Desaquedero of San Luis. Of one species of locust he notes the following singular fact in natural history:

We passed on the road a swarm of large grasshoppers or locusts, apparently at war with strange-looking black flies, about the size and shape of wasps, and having *a red spot* on their tails. Their hostility to the locusts seemed to be wholly wanton, for I could not observe that they did more than kill them. We had before seen myriads of small locusts, generally feeding on young algarobas, but had not seen any as large as these.—(*Vide* Gillis Exped., 2d vol., p. 24.)

Public advices from the Argentine States, of February, 1858, mention that the provinces of Entre Rios and Corrientes were desolated by swarms of langostas or locusts, which had caused great injury to the cattle pastures and the commerce of the country.[102]

In speaking of the pampas between Mendoza and Buenos Ayres, and their Indian inhabitants, Padre Ovalle says (about 1640), in his 7th chapter of third book:

They make bread of the cods of a tree, which we call in Spain algazoba (mesquite), and, because that does not last long, they have invented a strange sort of bread, made of locusts; for the locusts used to be in such vast quantities in those great plains called the *pampas*, that, as I traveled over them, I often saw the sun intercepted and the air darkened with flights of them. The Indians observe where they alight to rest,

[102] A. S. Taylor's MS., received from the Smithsonian Institution.

and those plains being here and there full of thickets, they rest in them and choose the highest for shelter. This the Indians know, and approaching softly in the night they set fire to the thicket, which, with the high winds that reign in those plains, is soon reduced to ashes, and the locusts killed; of these they make great heaps, and, as they are ready roasted, they have nothing more to do but to grind them to powder, of the flour of which they make a sort of bread which maintains them.

Ovalle was a Jesuit missionary, a native of Chili, who had resided in these countries for many years, and published his history of Chili at Rome in 1846, an abstract of which appeared in English in Churchill's Collection of Voyages, published in London in 1745.[103]

THE LOCUSTS OF THE OLD WORLD.

That the calamities which have befallen the farmers of the West are less grievous than those resulting from locust invasions in the Old World; that there is a general similarity in the habits of locusts the world over, and that the causes of their migrations are of the same general nature, may be seen by a perusal of the following statements, which we have taken from sources as a rule inaccessible to most readers. For brief popular accounts of the Old World locusts the works of Kirby and Spence, Westwood, and of subsequent compilers may be consulted. The following historical sketch of locust invasions in the Old World is condensed from an article by Rudolf Gottschoff in "Unsere Zeit" (February, 1876, Leipzig). The first account after that of Joel, in the Bible, whose remarks apply to Egypt, Syria, Palestine, and Asia Minor, is the statement of Ororius, that in the year of the world 3800 certain regions of North Africa were visited by monstrous swarms; the wind blew them into the sea, and the bodies washed ashore "stank more than the corpses of a hundred thousand men." Another locust plague, resulting in a famine and contagious disorders, according to St. Augustine, occurred in the kingdom of Masinissa, and caused the death of about 800,000 men. Pliny states that the locusts visited Italy, flying from Africa. In Europe locust invasions have been recorded since 1333, when they appeared in Germany. Mouffet states that in 1478 the country about Venice was invaded, and 30,000 people died of famine. In 1725 the region about Rome was overrun by locusts.

In France, swarms appeared at the close of the middle ages. In 1747 there was a great invasion of Southern and Middle Europe, especially the shores of the Danube, Wallachia, Moldavia, and Transylvania. Before and after this date vast swarms were observed in Africa and Asia. Adanson in 1750 observed them in the Senegal. In 1799, Jackson, in his "Journey through Morocco," states that the whole country between Mogador and Tangier, on the borders of the Sahara, was covered with them, and they were in many cases borne into the ocean westward.

In Russia, whose southern steppes form the home of the locust, vast swarms in the time of Charles XII, who was then in Bessarabia, came there from the region of the Black Sea. Russia, Poland, and Hun-

[103] A. S. Taylor's MS., received from the Smithsonian Institution.

gary were often visited by them. In 1828 and 1829 enormous swarms invaded the coast of the Black Sea. In 1859, in the South Russian provinces of Cherson, and in Bessarabia, a tract 60 versts long and about one-third as wide was overrun by them. Taschenberg gives the locust years in Russia in the present century as follows: 1800, 1801, 1803, 1812–'16, 1820–'22, 1824 and 1825, 1828–'31, 1834–'36, 1844, 1847, 1850 and 1851, 1859 and 1861.

In August, 1384, according to Mr. J. Boll, they invaded portions of Switzerland.

In Germany the records go back to 1333. In this year, and until 1336, they abounded. Entering Hungary, they overflowed into Poland and Austria. They then divided into two great swarms, one of which flew southerly into Italy, the other into France, Suabia, Bavaria, Thuringia, and Saxony. In Germany they again occurred in 1543. In 1693 they invaded Thuringia, going from Hungary by way of Austria, Silesia, and Bohemia, and invading the region about Jena, Gotha, Erfurt, and Weimar.

In Germany the locust years were as follows: 1333–'36, 1475, 1527 and 1543, 1636, 1686, 1693 and 1696, 1712, 1714, 1715, 1719, 1727–'31, 1734, 1746–'50, 1752–'54, 1759, 1761, and for the present century, 1803, 1825–'30, 1856, 1859. In 1873–'74, small numbers appeared in swarms about Genshagen, near Berlin; they laid their eggs, and in the middle of June of 1875 the larvæ appeared in millions, becoming fledged in July.

Köppen has published (Horæ Soc. Ent. Ross. iii, pp. 89–246) an elaborate memoir on the migratory locust of Southern Russia. He gives, in the first place, a bibliography of his subject, which includes several memoirs published in Russian journals. With regard to the species, Köppen remarks on the various opinions of entomologists as to the relation between *Pachytylus migratorius* (Linn.) and *P. cinerascens* (Fabr.), and comes to the conclusion that the two supposed species are to be regarded as varieties of one and the same, and that *Œdipoda tatraica* (Motsch.) is identical with *P. cinerascens*. The form which he met with most abundantly in South Russia is the true *P. migratorius*.

The development of the insect is described by Köppen in detail. The eggs are deposited by the females, to the number of 60 to 100 together, in little nests surrounded by a membranous envelope. The eggs are laid in autumn and the young hatched in the following spring. The envelope is burst a little while before the exclusion of the young. The eggs display a great power of resistance to the influence of cold; they have been found when placed with earth in a large glass vessel to retain their vitality when the temperature reached 26° Fahrenheit.

The larvæ are said by Köppen to moult four times, and the fourth moult produces the winged insect. The different stages are described by Köppen. At the end of May (1861), eggs taken from the ground showed the eyes, antennæ, segments, and legs of the larvæ distinctly; and a little while before hatching, the larvæ could move within the egg.

On its emergence the larva is yellowish-white, with a rosy tinge; in three to four hours its color is grayish-black. Before and during each moult the larvæ are sluggish. At the final moult, which always takes place in the hottest sunshine, the animals hang head downward, by the hind feet, upon the stalks of grasses, &c. This enables the insects to twist about in all directions, in order to free themselves from the skin. The expansion of the wings occupies about twenty minutes after the completion of the moult (twenty-two minutes according to Köste, who says that the moult itself occupies sixteen minutes); during this period Köppen observed that a dark yellow fluid was distributed over the wings in microscopic drops. The period which elapsed between the arrival of the insect at the winged state and the deposition of the eggs is uncertain; the statements of different authors vary between four weeks and two months.

Köppen describes the nearly indiscriminate voracity of these insects, but remarks that certain plants appear to be avoided by them, namely, flax and hemp, the *Cucurbitaceæ*, and, according to Petzholdt, dwarf garden-beans. The *Gramineæ* seem to furnish their favorite food. They prefer the leaves and other soft parts of plants and trees, but also sometimes gnaw the bark and even the wood of the latter. In time of scarcity they will attack straw-thatch and woolen clothes, and even devour each other. Köppen notices the statement made by various authors that the larvæ for the first ten days live upon dew, and treats it as an absurdity.

The perfect insects copulate almost immediately after the last change of skin. The union of the sexes continues apparently for a considerable time, from twelve to eighteen or even twenty-four hours, but sometimes only for an hour or two. The female carries the male about with her, and feeds as if alone; she is, however, unable to fly. The male sits quite motionless, only giving a sign of life by stridulation if another male should approach.

The eggs are deposited about seven days after copulation, according to Köste. The female digs a hole in the earth of about 1½ inches, by means of the hook-like horny organs of the apex of the abdomen, and the eggs are then laid in cylindrical masses, usually placed at an angle of about 45° to the surface. The eggs are united by a spongy mass (cement), which also envelopes the whole outside of the mass; here, by the adhesion of grains of sand, small stones, &c., it forms a sort of wall which protects the eggs from injurious external influences. The mass is sometimes formed wholly or partially of the frothy cement without eggs. Yersin ascribes this to a morbid condition of the female, and doubts whether the few eggs contained in such masses are capable of development. Köppen has found, on removing the female insect, that the pit which it had dug was filled with the frothy mass without any eggs. This seems to the recorder to indicate rather that the cement mass is first produced by the insect, and the eggs afterward laid in it.

The nests found containing the spongy mass without eggs would then be easily accounted for, on the supposition that the females were disturbed or destroyed when just about commencing the actual business of oviposition. The number of eggs laid in each nest seems to vary from 50 to 90 or 100, and the ovary of the female contains from 100 to 150 eggs, according to Krünitz. The question whether the females copulate more than once has been much discussed in Russia, and from the author's statements it would appear that the popular opinion is that the act of copulation only takes place once. From Köste's observations, however, it is certain that the females copulate and deposit their eggs several times. He observed a female in confinement which copulated with six different males before laying her first batch of eggs; and afterward the same phenomena were repeated four times, the insect dying when engaged in oviposition for the sixth time. From his own observations, and those of other authors, Köppen regards it as most probable that copulation and oviposition are repeated usually at least three times by each female, perhaps at intervals of about a month, as stated by Yersin, the total number of eggs being from 160 to 170.[104]

Upon the rapidity of movement of locusts in the larval condition the statements of authors are at variance. The observations of Sydon and Dönzingk give about a quarter of a German mile (*i. e.*, about 0.975 mile English) in the hour. Téchemewsky asserts that they only advance about 350 feet in the day upon grass land.

Of the senses of the locust, Köppen seems to regard hearing as the sharpest. The senses of smell and taste are exerted in the selection of food; and that of touch is displayed in the sensibility of the insects to changes of weather, especially temperature. Sociability is regarded by the author as characteristic of the locusts. The larvæ proceeding from one nest seem to keep together for a time; they afterward associate in larger masses which move together in search of nourishment. These migrations in mass commence in the second stage of larval life, but become more general after the second moult. The migration usually takes place in the morning and evening. The author remarks upon the direction of the migrations of these insects, which he regards as influenced to a certain extent by an instinctive perception of the direction in which abundant food or a suitable breeding-place is to be found, but modified or even sometimes caused by external agents, especially the winds. The author also discusses the primary causes of the great migrations of these insects and the phenomena observed during their flight.

In the south of Russia the hatching of the eggs takes place, according to the weather, at the end of April or beginning of May. A few larvæ

[104] In an article by V. Graber "On Polygamy and Other Sexual Relationships in the *Orthoptera*" (Verhandlungen der zool.-botanischen Gesellsch. in Wien, xxi, pp. 1091–1096, Zoological Record for 1871), the author details experiments regarding polygamy and repeated copulations in some orthopterous insects. A male and female were observed *in coitu* eight distinct times between May 21 and June 1; after the sixth connection the female began to deposit eggs. A second male, which had already fecundated several females, was then placed with her, and she paired at least five times with him. Analogous results followed experiments upon *Pezotettix pedestris*, and he believes that polygamy and polyandry exist in many species.

are sometimes produced on warm days in October, but these soon die. The hatching occupies from two to three weeks, according to circumstances. The winged insects appear in the beginning and middle of July; copulation takes place early in August; and the oviposition extends from the middle of August to October. The dry steppes constitute the chief haunt of the locusts; damp places they seem to avoid. The females prefer for the reception of their ova the solid virgin soil, and rarely visit plowed land for this purpose. Damp and cold are unfavorable for the development of the eggs. The author discusses in great detail the external conditions which act favorably or unfavorably upon these insects. The greater part of this section is devoted to the consideration of their enemies, of which Köppen gives a formidable list (pp. 151–166).

Leimé and other authors have given Tartary as the true home of the migrating locusts; but in Tartary no large swarms occur. In the author's opinion, the countries in which the swarms are seen are also the countries of their birth. He cites many facts in support of this opinion, and in illustration of the geographical distribution of the insect, the northern limit of their migratory or nomadic life being a line passing from Spain through the south of France, Switzerland, Pomerania, South Russia, and South Siberia, to the north of China. To the north of this line the insects generally occur only singly. Many interesting details as to their occurrence in vast numbers are given by the author (pp. 190–205).

Köppen also describes the injury done by the locusts when they occur in great numbers, and indicates the means adopted for their suppression (pp. 205–246).

Köppen also notices *Caloptenus italicus*, a congener of our *C. spretus*, which likewise occurs in South Russia, and at such times, as in other regions of Southern Europe, sometimes in injurious numbers. Other species which are also occasional devastators, especially when associated with the migratory species, are *Pachytylus stridulus*, *Œdipoda vastator*, *Stauronotus vastator*, *S. cruciatus*, and *Pezotettix alpina*.

Küntsler reports this insect as injurious to corn-crops in Austria in 1866 and 1867.

The ravages of the locust in Bavaria have been discussed by Jaeckel,[105] who cites various records of the visits of this species in swarms during the fourteenth century, one toward the close of the fifteenth, and one at the end of the seventeenth century, and gives a long account of a similar visitation in 1749. Since that year no swarms of locusts have occurred in Bavaria.

Gerstaecker, in a recent work[106] on the European locust, which seems to

[105] Correspondenz-Blatt des Zool. Mineralogisch. Vereins, Regensburg, xxi, pp. 83–93. See Zoological Record for 1867, Verhandlungen Zool.-Bot. Gesellschaft in Wien, xvii, pp. 930–932, Zool. Record for 1867.

[106] "Die Wanderheuschrecke. (Oedipoda migratoria Lin.) Gemeinverstaendliche Darstellung ihrer Naturgeschichte, Lebensweise, Schädlichkeit und der Mittel zu ihrer Vertilgung. Im Auftrage des Königl. Preuss. Ministeriums für die landwirthschaftlichen Angelegenheiten verfasst von Dr. A. Gerstaecker, Prof. an der Universität in Berlin. Mit 9 Abbildungen auf 2 Tafeln in Farbendruck. Berlin, 1876. 67 pp."

For the above translation we are indebted to Mr. Whitman.

be mainly, however, a compilation, writes as follows regarding the European locust:

That copulation can be accomplished very soon after emerging from the last larva-skin (he does not name a *pupa stage*), is shown by the fact that one occasionally finds individuals engaged in the act while the wings are still tender and have not attained their full color. But the act is as a rule performed in the course of several days (after becoming winged), or even after a still longer period.

The male lets the female free in the course of twelve to twenty minutes, after which the female before proceeding to lay, employs herself in feeding again for several days. As soon as her eggs are ripe, which, according to Kösten, requires seven days on the average, she seeks a satisfactory spot to deposit them. (He then describes the act of laying, which is much as in *C. spretus*.) The eggs are generally found at a depth of 4 centimeters, or more, below the surface. In this act, requiring considerable time, she by no means rids herself of her whole stock of eggs at once, but may pass several weeks even in perfecting them. Possibly for a second or third deposit of the egg-mass a renewal of copulation is necessary. At least such a repetition has been noticed in the case of females that had already been found laying, and has always been followed by a new deposit of eggs. In all cases, whether after a single or repeated coupling, which latter may depend upon the relative number of males, and the temperature of the season, a division is made of the egg-stock into several deposits as is shown by the fact that the larger egg-pods seldom contain more than one-half, and the smaller very generally a much smaller fraction of the whole mass of eggs produced by one female, which mass may amount to one hundred and fifty or more. With the last deposit the female has accomplished her destiny, so that she not seldom remains dead on the spot where the laying occurred. On the other hand the males even after repeated coupling, and with several females, appear to be able to prolong their life, and may be found alive as late as October.

From the comparatively long time during which the winged locusts may be found, extending very commonly from the end of July to the end of September, it must not be at once concluded that the life of an individual is correspondingly long.

In selecting a spot for the perfection of this egg (packet) dryness is of the first importance to the female, and besides this a certain degree of hardness. They prefer loamy and clayey ground to pure sand. Besides this, a spot is naturally selected which offers suitable and plentiful food to the hatching brood.

Fallow fields lying alongside cultivated fields and meadows appear to present an unusual attraction to the female when ready to lay. That the eggs, as such, winter over under the surface can be set down as a matter of common observation. The young brood generally do not hatch before the end of April.

The geographical distribution of the migratory locust of Europe and Asia (*Pachytylus migratorius*) has been discussed by Herr F. T. Köppen in Petermann's "Mittheilungen aus Justus Perthes' Geographischer Anstalt" (1871, p. 361), his paper being accompanied by a map showing the range of the insect. We translate an abstract of it by M. Preudhomme de Borre, in the Comptes Rendus of the Entomological Society of Belgium, 1871–'72, p. xviii:

The migratory locust is an *Orthopter* peculiar to the torrid zone and a large part of the north temperate zone of the Old World; but, in this last region, its northern limits is subject to some variations, the explanation of which is one of the principal objects of the work of M. Köppen.

In countries such as those of Arabia and Persia, where the mean temperature of the year, as that of the different seasons, is almost invariable, the abundance of the species in question does not vary; it is normally limited, both by the quantity of its nourishment and the natural enemies of the insect. But this is not the case in those countries

which, like Southern Russia, may present, sometimes favorable seasons, sometimes years, or even simply seasons, unfavorable to the multiplication of *Pachytylus*. Thus, according to M. Köppen, the persistent prolongation of dry heat during a part of the autumn will exert an influence on the quantity of eggs laid in favorable places; and, on the other hand, a temperature less than 14° Réaumer [63½° Fahr.], prolonged for several days toward the end of May, will be indispensable to the hatching of the larva. There would result from the more or less perfect realization of these conditions, and their succession or their interruption during several years, those differences observed in the northern limit of the species, which alternately increase or diminish the area of distribution.

M. Köppen has distinguished and traced quite completely on the map for Europe and Siberia three different limits of the geographical area of *Pachytylus migratorius*: 1. The limits of its permanent distribution. 2. The limit of its temporary existence in all stages of development, a little more to the north. Finally, 3. The limits of its presence in the condition of bands of winged insects of a stated age, out of the regions where the species may live and propagate. It will be necessary still to establish the limits of accidental individual appearances, but that would be of questionable importance. The northern limit of the permanent geographical distribution of *Pachytylus migratorius* begins in Western Europe, from the coast of Portugal, near 40° latitude north, and extends from there toward the northeast as far as the mouth of the Bidassoa, thus leaving out all the northwest portion of Spain; it continues to rise obliquely in France up as far north as the lake of Geneva, and extends east, following more or less the forty-eighth degree of latitude, and embracing Valois, all of the north of Italy, Carinthia, and Hungary, it passes into Southern Russia, where it attains nearly the fiftieth degree, passes likewise across the middle of Siberia, whence it passes over the north of China, to end in Japan, at a latitude a little inferior to that of its point of departure in Portugal, leaving out the island of Niphon. M. Köppen remarks that all this limit does not deviate much from the isothermal of 16° R. [68° Fahr.] for the month of June. To farther circumscribe the area, so extensive, of this species, the line goes from Japan to the islands of Fidochi, to New Zealand and Australia, of which it only embraces the northern parts, passes from there to the island of Mauritius, then rises to the north, crosses Africa up to Madeira. But in this last part of the passage the limits are more hypothetical, from want of an exact knowledge of the existence of the species in the interior of Africa.

When, in a country comprised in this area, as has been frequently observed in Southern Russia, the locusts develop in a certain abundance, the want of food obliges them to migrate in part in different directions, and to break over their limits. If circumstances permit these emigrants to multiply for a certain period beyond their normal area, there results a temporary extension of this area, and occasionally new migrations to the north, until only a single spring, colder or more humid, comes to put an end to their invasion and to oblige them to go back to their natural limits. Temporary extensions like this of the area of distribution of *Pachytylus migratorius* took place in 1746 to 1749, and in 1822 to 1828; at these periods they appeared in Germany, and have multiplied themselves during several successive years. The northern limit of these temporary extensions may be also marked on the chart by a line which, taking its point of departure in the southwestern portion of Bavaria (where the *Pachytylus migratorius* has been observed from 1333 to 1339, and from 1748 to 1749), rises to the northeast by Jena and Halle toward Jüterbogk and Berlin, when it takes a nearly eastern course, following more or less the parallel of 52½° of latitude, near Müncheberg, Küstrin, Birnbaum, and Posen (regions which the species was known to have visited in 1730, 1752, and from 1827 to 1828); then the line passes across Southern Poland, at the fifty-second parallel, through the southern part of the government of the Mohilew, inclining gradually toward the south, and extending so as to reach the Wolga and the Ural. It is apparently to the humidity of the climate, injurious to the locust, likewise to the state of the eggs during the winter, that we should attribute the less extension of this limit toward the north in Western Europe.

To the north of the limits which have just been indicated, the *Pachytylus migratorius* has not the power of undergoing its whole cycle of metamorphoses, neither, consequently, to reproduce itself. This does not prevent its occasional appearance in swarms even in countries very northern; thus, it was observed in England (1693 and 1748), and even at the latter date near Edinburgh; in Sweden (as far as Ostrogoth), at latitude 57° to 58° north, in 1748 and 1844, and finally on the Duna, near Dunabourg, and at Polozk, in 1545. But these troops of voyagers did not hatch out in the same places where they were observed, nor did they leave any progeny in subsequent years. The only known example of an exception to this rule is the discovery made once by Boheman, in September, in the middle of Sweden, of a *Pachytylus migratorius* in the proper state. Evidently this is an exception wholly accidental, which does not prove anything against the rule. The more we advance toward the north, the less are large swarms of locusts observed, and we end by meeting only isolated individuals, as have been seen several times at St. Petersburg, and even near Wasa in Finland (latitude 63° north).

The want of facts prevents our extending these studies to the southern boundary of the area of distribution of *Pachytylus migratorius*. However, we can remark that in New Zealand, the extreme southern point of this distribution, the mean temperature of the warmer months is, according to Schmid (Lehrbuch der Metecrologie, p. 363), at 15°.5 R. (about 66° Fahrenheit), which does not differ much from the corresponding temperature of the northern limit of the area in Europe.

The localities out of Europe where the *Pachytylus migratorius* has been observed are as follows: Madeira, Algeria, Tunis, Egypt, Chartoum, Asia Minor, Syria, Arabia, Persia, India, Siam, China, Japan, Java, Luçon, Fidschi, New Caledonia, New Zealand, Northern Australia, and finally Mauritius Island; but this last locality indicated by Serville needs confirmation. In Central Asia the species has been observed near Lake Aral, on the borders of Syr-Darja, on the upper side of Ischim and of Irtisch, and finally toward the lakes Kurgaldschin, Nor-Saisan, and Balchaasch.

According to M. Köppen, the great chains of mountains are a powerful obstacle to the diffusion of *Pachytylus migratorius*. The Alps especially play a large part in its distribution in Europe, and it is without doubt to them that we should attribute its relative rarity in the countries of the southwest of Europe and northwest of Africa, where it is almost completely replaced by other species of the same group, *i. e.*, the *Caloptenus italicus* in Spain, Italy, and in the middle of France; the *Acrydium peregrinum* in Algeria.

It should be observed that this species, and in general all the *Acrydiidæ*, shun mountainous and wooded countries. They are most fond of the plains, of regions quite dry, and it is also a circumstance which influences necessarily their geographical distribution.

"The development of the organs of flight of the migratory locust," continues M. Köppen, "determines the facility and the amplitude of its flight, and consequently favors its migrations. They are evidently the cause of this colossal geographical distribution of the species. They remind us of the remark of Darwin, that species rich in individuals and with a wide habitat, which, owing to their organization, have had in their country the pre-eminence over many surrounding species, are those which, in the case of emigrations out of their area, should have the greater chances of overrunning new territories."

Köppen examines successively the causes which may determine the migrations of this orthopter in armies more or less numerous, and then the observed direction of these movements. It is said that they fly more often from east to west, but M. Köppen thinks that it is not necessary to attribute this circumstance, as has been done, to the predominance of the east winds at times when the sterility of the country that they inhabit, increased still by the prevalence of these same winds, forces them to seek places which can furnish them a more abundant pasturage. Numerous facts appear, he says, to contradict this explanation. In reality, the movements of these hordes is rather centrifugal, as M. Köppen establishes from observations made especially in the plains of Eastern Europe; that is to say, that all the migrations appear to radiate

from countries where the species breeds most. In Europe they would consequently be directed to the west, while in China they should have a direction ordinarily toward the southeast.

M. Köppen thinks that the same centrifugal radiation has presided over the scattering of this species beyond its original limits, and that this radiation, propagating in waves, such as we still see produced at the limits of its geographical area, has carried the species from its center of creation or its original country to points where it is powerless to overcome the climatic conditions or that concurrence of vital forces which are opposed to it. The center of creation or the point of departure of the species will be found, then, in Central Asia. The complete absence of this species on the American continent shows that it only began to exist as a species after the epoch of the separation of America from the Old World.

M. Prendhomme de Borre adds, "In this study, so interesting, there is one point on which we should insist. It is this: That the observations of M. Köppen tend to confirm the principle of zoological geography, that the area of a species cannot be limited on the map by a simple curve, but between places where the species exist in a constant or normal manner and those where its absence is constant there is always a zone, often very broad, of temporary visitations, which is to the area properly so called what the penumbra is to the light, within the zone, of which the exterior limit is much more easy to trace than the inner; this last is subject to continual oscillations, with some undulatory movements, dependent on the centrifugal or expansive tendency of the species, and from the resistance which opposes it, and external circumstances, and evidently also the tendency of other species to spread out, with which it carries on a struggle for existence in endeavoring to maintain itself on an earth where the chances are divided, and even vary from year to year. M. Köppen has thus been enabled to figure on his chart three lines, as I may for the present call them, and the intermediate line represents the exterior actual limit of these oscillations of the true frontier line of *Pachytylus migratorius;* their amplitude may vary from two to four degrees."

The last thesis of M. Köppen that I shall draw attention to at this time, namely, that the absence of *Pachytylus migratorius* in America should prove that the species exists only as a species, since the separation of the two continents toward the north pole, seems to me scarcely necessary. A mere glance at the map which represents the area of distribution of this locust allows us to affirm without hesitation that that view is impossible. It is evidently not one of those species which we may call *circumboreal anteglacial*, because their presence in two forms (races, varieties, or species) on each continent indicates that they have had a common origin, a single area at that epoch, anterior to the glacial period, when the two continents were reunited in the Arctic zone by a bridge, so to speak, that is, a continuity of land, in conditions of climate which should allow the existence at that latitude of a fauna which only at present exists much farther south. The source of those species dispersed by the glacial period does not now probably exist in its integrity; but the two races confined, one in America, the other in the Old World, having undergone slow modifications each on its part, are to-day very analogous species, but as distinct by their external characters as by their separate geographical area.

Nothing like this applies to *Pachytylus migratorius;* it is one of those species which may be called *equatorial postglacial;* its expansion toward the north has been posterior to the glacial period, which would then have opposed it; and it can have no affinities in the New World, but degrees of consanguinity much farther removed than those unite the circumboreal species of the temperate zone. Thus, if, as some think, the northern hemisphere tends actually to retrograde toward a new period of cold, the *Pachytylus migratorius* is destined to see its area also retrograde toward the equator, and perhaps some day the western and eastern parts of this area may be completely disjointed, and, following this separation, its posterity may be so modified by isolation as to form two distinct species, as has occurred to circumpolar species.

In the discussion which followed, M. de Selys-Longchamps speaks of the difficulty of separating *Pachytylus migratorius* (Linn.) and *cinerascens*

(Fabr.), which he had at first regarded as varieties, but now considers as a distinct species, the latter being more sedentary and reproducing in Belgium year after year: "M. F. H. Köppen not speaking of *cinerascens*, it would be interesting to know whether he admits this species, and if in the affirmative, whether all his remarks apply alone to the true *migratorius* type, notably that which he says normally sojourns at Bayonne, where I have taken only *cinerascens*, variety *virescens*, whose characters are the same as in Belgium and Frankfort-on-the-Main. It is also *cinerascens* that M. von Heyden has taken."

Some notes on the Algerian locusts (*Acrydium peregrinum*, *migratorium*, &c.) by Coure, have been communicated to the Entomological Society of France by Giraud. In them, mention is made of a special work on the same subject, which the recorder has not yet seen (Bull. Soc. Ent. Fr., 1867, pp. x, xiii). The locusts visiting Algeria come from the south and arrive in May. They lay their eggs soon after their arrival, and the young animals produced from these eggs usually become adult in July. In August all usually disappear. Coure also notices the arrival in Algeria in the early part of January, 1867, of a flight of locusts. The color of these was stated to be reddish. It appears that on first attaining their adult form these insects are of a rosy tint, and afterward change; and Coure thinks that it is not until after their change of color that they are fitted for reproduction. Lallemant states (*l. c.*, p. xiii) that the locusts, which live for a long time in the adult state, are at first rosy, then emigrate southward, and return in winter with their mature color.

In Spain, during the summers of 1875 and 1876, *Decticus albifrons* (Fabr.) was abundant and injurious, but less so in 1876 than the year previous, as the soldiers assisted the inhabitants of the district infested in destroying them.

The secretary read a letter he had received from the foreign office department, inclosing a dispatch from Her Majesty's minister at Madrid, relative to the steps taken to check the ravages of the locust in Spain. It appeared that considerable apprehension had been felt in many parts of Spain that the crops of various kinds would suffer greatly this year from the locust; and the Cortez had already voted a large sum to enable the government to take measures to prevent this calamity and by a circular addressed to the provincial governors by the minister of "Fomento," published in the Official Gazette, they were directed to make use of the military forces stationed within their respective districts, to aid the rural population in this object. It was stated that thirteen provinces were threatened with this plague.—[*Proceedings of the Entomological Society of London*, 1876, pp. xiv and xv. May 3, 1876.

A letter was read from T. V. Lister, esq., of the foreign office, transmitting for the information of the Entomological Society a copy of a dispatch from Sir John Walsham, Her Majesty's chargé d'affaires at Madrid, relative to the plague of locusts, together with a box containing

specimens of the insect and a number of earthern egg-cases, each containing from thirty to forty eggs. The dispatch stated that the official report showing the progress of the plague and the steps taken to exterminate the insect had not yet been published, but a copy would be sent the society in a few weeks. It was said that the damage done by the locusts this year was considerably less than that of last year, owing to the number of soldiers which the government had been able to employ since the war was over to assist the inhabitants of the district where the plague existed in destroying the insects. The insects sent were stated to be specimens of *Locusta migratoria*, but on examination they were found to be the *Locusta albifrons*, Fabr. (*Decticus albifrons*, Savigny).—[*Proceedings of the Entomological Society of London*, 1876, p. xxi. August 2, 1876.

In China records exist of the appearance of locusts in devastating numbers one hundred and seventy-three times during a period of nineteen hundred and twenty-four years, as stated by Andreozzi, who has translated, from a Chinese work on agriculture, notes respecting the ravages of locusts in China, and the superstitions existing among the Chinese with regard to their origin. The three great causes of famine in China are placed as flood, drought, and locusts.

In 1876, Col. Prejvalsky states that swarms of locusts were seen at an elevation of 9,000 feet in the Altyn-Tag range, in Central Asia.—[*Geographical Magazine*, May, 1878.

In Southern Australia locusts of an unknown species committed ravages in 1872.—[See *Proceedings of the Entomological Society of London*, 1872, pp. xii and xvii.

Swarms of locusts have appeared in several of the Philippine Islands, and have caused immense damage in the plantations. Public prayers were offered up, and the common people employed in the fields in collecting and destroying them, the authorities paying so much for every basketful presented to the alcaldes. It does not appear that the natives of the Philippine Islands eat the locusts, as the Riff Arabs do. The latter, when they see a cloud of locusts hovering in the air and clouding the sky, watch them anxiously, and if they descend near their *adwars*, receive them with shouts of gratitude to God and Mahomet, throw themselves on the ground and collect them as fast as possible. Previously deprived of their heads, legs, and wings, the locusts, well boiled in butter and served up with *alcuzcuz*, are considered by the Riff Arabs a delicious food. Their camels eat them greedily.[107]

[107] Received from the Smithsonian Institution.

APPENDICES.

The following appendices embody a large number of data collected by the Commission during the year, as well as its more important correspondence, special reports, classified answers to circulars, list of correspondents, bibliography, etc., etc. They comprise very many interesting and important facts and experiences upon which we have drawn for our generalizations, and which will always be valuable for future reference. Yet to have incorporated them into the main text of the report would have swelled the bulk of the volume to unwieldy dimensions. The miscellaneous data from the different States have mostly been arranged chronologically, and form a detailed history of locust injury in 1877. The replies to circulars have generally been classified to facilitate reference, and also arranged by States. When no other authority for a fact, statement, or report is given, it is to be understood as taken from the correspondence of the Commission.

APPENDIX I.

MR. ALLEN WHITMAN'S REPORT FROM MINNESOTA.

SAINT PAUL, MINN., *December* 20, 1877.

SIR: I have the honor to submit the following report of observations upon the Rocky Mountain locust in Minnesota during the year 1877:

A report upon the locust in Minnesota in 1877 properly begins where the report of a preceding year closed, with the deposit of eggs in the year 1876. The amount and extent of these deposits were determined last year from circulars sent to most of the infected counties, inquiring—

1. The dates between which locusts had appeared in greatest numbers.
2. The dates between which they had appeared to deposit eggs in greatest numbers.
3. The extent of the deposits; and
4. How late in the season locusts had remained.

Replies to these circulars were received from three hundred and fifteen townships in thirty-two counties, and reports of a similar nature were received from the auditors of those counties which were not attacked until late in August or in September. The information derived from all these sources denoted in general that the portion of the State in which eggs were laid more or less thickly was bounded on the west by the State line, nearly, from Moorhead, on the north, to the Iowa line, while on the south the deposit reached eastward to about the longitude of Austin. On the north and east the boundary line was irregular. Starting from Moorhead it included the southern part of Clay County, the southwest corner of Becker, the southern part of Todd, the extreme southwest corner of Morrison, and reached the Mississippi at Sauk Rapids. The eastern limit from Sauk Rapids southward was along the Mississippi River (a few miles to the east of it) to Elk River, thence southward, including portions of Hennepin, Scott, Rice, Steele, and Mower counties. This was the line as shown in a map of the locust area in Minnesota contained in "A Report of the Geological and Natural History Survey of Minnesota for the year 1876," published by the State University. It was intended to show the extreme eastern limit of the egg-deposit for the year, and the hatching of 1877 has proved its general correctness. But while it was drawn far enough to the east to include all or nearly all the scattering squads of locusts that hatched during the spring along the eastern limit of the locust-area, the limit of severe injury lay, in most cases, many miles to the west of this boundary line.

The line, as drawn, included the whole or parts of forty-four counties. It was well known during the fall that in many of these counties the number of eggs deposited was too small to excite any fears of serious injury from the young locusts. This was particularly true of Red River Valley, and of considerable portions of the hatching grounds of the spring of 1876, which for some reason had been passed over during the summer without receiving any great amount of eggs. In still other counties lying along the eastern portion of the egg-area there was reason to fear that the eggs were deposited in sufficient numbers to cause serious damage. In still other counties lying in the central portion of this area it was well known that eggs had been deposited in greater numbers than in any preceding year. It was known not only from the fact that certain favorable spots were found to be densely packed with eggs, but also from the fact that the laying had begun early in the season (by July 10 in many townships), and had continued through July and August, and that two, three, or even four bodies of locusts had followed each other during the summer, and that each had left eggs behind. There was good reason for the gravest apprehensions, and the legislature used its best endeavors during the winter to devise a plan by which the evil might be somewhat averted. That this plan, as devised (a bounty for the destruction of the young locusts in the spring and summer), was so palpably inadequate as to bring its own futility with it, is due to the fact that when the hatching fairly began the young came forth in such immense numbers in some ten or twelve counties that the whole provision for their destruction would have been more than exhausted in these alone, leaving all other counties to shift for themselves; while in other parts the hatching was so scattered and uncertain that plainly no one plan of enlisting a common warfare could be adopted throughout the whole infested area. Under these circumstances the idea of a bounty was gradually abandoned, and county and town authorities, and

the farmers in general, were left to adopt for themselves through the spring such measures as seemed best adapted for immediate success. It may be added that there is very trifling reason to regret that the bounty bill, as passed, proved a failure at the very outset. As a means of defense, it would have proved useless in some cases and needless in others. As a matter of relief or reimbursement for injury, it would have gone in a large measure to help those who are already repaid by an abundant harvest.

But the fact that in a large number of counties where serious injury was anticipated the damage has been partially or totally averted; that in many cases extensive deposits of eggs were either followed by a limited amount of hatching, or that the injury begun by the young in the spring was continually on the decrease until the locusts finally departed; in short, the fact that what may perhaps have been Minnesota's most destructive locust year is probably its best wheat year, is due to a combination of causes. These are a limited amount of destruction of eggs through the efforts of the farmers in the fall of 1876, a considerable destruction of the same by insect enemies, birds and other animals, the destruction of the young by individual efforts during the spring, and more than all else by a series of fortunate climatic conditions, especially during the spring and early summer months, which, while they were in every respect favorable for the growing grain, were throughout unfavorable for the development of the locust. This again was followed in July and August by migrations so totally different from those of former years that they were almost entirely harmless. To sum up the result, the damage, so far as concerns wheat, is, according to the statement of the commissioner of statistics for Minnesota, the Hon. T. M. Metcalf, confined to nineteen counties, containing a wheat acreage of 337,188 acres. Of these nineteen counties, two suffered a "total loss of wheat; one slightly injured; eight counties are believed to have saved half a crop; one, a third; one, a tenth; two, two-thirds; three, three-quarters; and one, four-fifths." These statements were drawn from "the most careful estimates of the bushels harvested by these counties," and while they are only estimates, it is not probable, judging from past experience, that accurate statistics will add to the amount estimated as destroyed. This is a result not only different from what was expected at the beginning of the season, but also different from what would have been had the spring of 1877 been similar to that of 1876. In the latter case we should have seen serious destruction in a still larger number of counties, and a still longer list of counties injured.

This impending danger aroused the farmers to unusual exertions during the fall of 1876. In counties where the trouble was an old one, conventions were held and measures taken to prevent the prairie-grass from being burned before the hatching season of 1877. To preserve this grass and fire it just at the time when the locusts were hatching, seemed to be one of the most feasible methods of general destruction, and one which in past years had commended itself to the citizens of the infested counties. It was carried into effect in the spring in such a way as either not to do all the good of which it was capable, or to show that it was impossible to produce anything like wholesale destruction, on a date specified beforehand, by this means. In other counties meetings were held by townships to provide for plowing up roadsides and other public places where eggs had been laid. In general a large amount of plowing and harrowing and dragging of fields and new breaking was done by the farmers in all parts of the threatened district. The reports of the results of this latter method of destruction are conflicting, varying according to the care expended upon the work, the lateness of the season at which it was done, and the accuracy with which the results were noticed. In cases where new breaking thickly filled with eggs was passed over once or twice with a seeder in November, or late in October, a portion of the eggs were left undestroyed, and these hatching in the spring, the young devoured the grain as fast as it grew. In other cases eggs brought to the surface late in the fall retained their vitality (the young were fully formed in the egg) during the winter, but afterward when they had been exposed, in February and March, to alternate heat and cold without a covering of snow, only a small fraction of them could be hatched. In other cases, where the number of eggs was not excessive, the proportion of eggs left undestroyed after fall harrowing was too small to cause (of themselves) any serious damage in the spring. From all the inquiries that I have been able to make during the season, I am confirmed in the statement made last year, that it is desirable to bring the eggs to the surface at the earliest possible moment after there is any assurance that the laying season is over; in other words, they should be exposed to the sun while their contents are still fluid.

The good effects of plowing the eggs under deeply are still more marked, wherever the work was thoroughly done. Even when turned under to a depth of five or six inches the hatching, except in most favorable positions, was, if it occurred at all, too late to do any injury whatever. Eggs plowed under in corn-land were found to be unhatched up to the 21st of June, but when brought to the surface they hatched at once; and without any question large numbers of eggs turned under in heavy grounds never hatch at all. At any rate it ought to be learned from the present year that with

a good growth of wheat we have nothing to fear from locusts that come straggling forth during the month of June.

A considerable amount of eggs were destroyed during the fall and spring by various insect enemies, birds, &c. It is difficult to estimate the amount of destruction that goes on in this quiet, unseen way, but from the abundance of these enemies (particularly insects) in certain localities, and from the palpable difference in such places between the anticipated and the actual hatching, it is evident that these agencies have all helped to make the result as favorable as it is. It has been a matter of common report that in spots where eggs were abundant in the fall few or none could be found in the spring; and this was generally stated as a fact without attempting to assign any cause for it. Even in 1876 replies to circulars, coming in during the fall, denoted that a portion of the eggs deposited early in the season had already disappeared. During the fall of 1876 reports were received from various quarters, especially the southwestern counties, denoting the presence of the silky mite in great numbers, while various larvæ were discovered at work upon the eggs almost everywhere. The silky mite was found to be still more numerous in the spring, sometimes so thick as to redden the ground, and in localities where it had not been seen in the autumn. Of replies to the inquiry of the Entomological Commission, "Proportion of the eggs that failed to hatch and probable causes of the failure," nine out of thirteen (in Minnesota) express the opinion that a large percentage (one-half or more) failed to hatch, and the cause generally assigned is the silky mite. Testimony on this point can apply with exactness to only such little areas as came under each man's particular notice, but the replies, taken with similar reports, denote that considerable quantities of the eggs were destroyed by various agencies before hatching.

EFFECTS OF TEMPERATURE AND RAIN-FALL UPON THE EGGS.

It is very doubtful whether excessive rain-fall during the autumn has any effect whatever upon the eggs, at least so long as they are left undisturbed. The following records of temperature and rain-fall have been kindly furnished by Sergeant J. O. Barnes of the signal office, Saint Paul:

	September.		October.		November.		Totals.
	Rain-fall.	Temperature.	Rain-fall.	Temperature.	Rain-fall.	Temperature.	Rain-fall.
	Inches.		*Inches.*		*Inches.*		*Inches.*
1873	2.56	54.1	2.57	41.3	0.79	27.6	5.92
1874	5.76	60.9	3.21	49.4	1.90	28.7	10.87
1875	2.16	57.2	1.56	42.8	0.84	25.2	4.56
1876	2.99	56.8	1.27	43.2	0.93	29.6	5.19

It will be seen that the total rain-fall of the autumn of 1874 is nearly equal to the total of any two other years in the series, and it is certain that it was not followed by any apparent diminution of the hatching in 1875.

Again, there are many instances where continued immersion of the eggs in the spring has no farther effect than to delay hatching until the moisture is removed. Statements to this effect have been repeated a few times in various journals, and I add the following extract from a letter, which seems to come from good authority:

"MARSHFIELD, LINCOLN COUNTY, MINNESOTA,
"*September* 10, 1876.

"On the 28th of August last, out on a hunting expedition, I crept down on the bank of a lake among the reeds to get a shot at some ducks. In the reeds, among a thick matting of tall wire-grass, I found millions of young hoppers just hatched. The eggs were deposited last July (1875) and remained through the winter, and the water in the lake, raised by spring rains, had stood over them until the first week in August and then receded, and when I was there the warm sun was hatching them out. The growth of grass indicated that last year, when the hoppers visited us, the water did not reach that point.

"C. H. GOODSELL,
"*County Auditor.*"

But the fact that moisture does delay hatching must be taken to prove that in a wet spring the hatching in low grounds or such spots as retain moisture will be retarded and uneven, exactly as has occurred during the past spring.

The hope that the mild weather of February succeeded by the cold of March would destroy the vitality of the eggs ended likewise in disappointment. The average tem-

perature at Saint Paul for the month of February was 32° above zero, being nearly 15° warmer than February, 1876, and more than 33° warmer than February, 1875. The months of March and April did not differ greatly from the same months in preceding years, and the thermometrical records show that the eggs have been subjected to alternate freezings and thawings every year. Thus in March, 1874, while the mercury rose above the freezing point on sixteen days, it ranged from 45° to 5° above zero, and fell on the 3d of April to 17° below zero. Again, in 1875, the mercury in March ranged from 38° to 1° above zero, and in April from 70° to 10° above zero. In March, 1877, the mercury rose above the freezing-point on eighteen days, and ranged from 45° to 50° above zero, while in April it hardly reached the freezing-point after the 2d day of the month. The transition from the hope excited in February to the reality of the hatching under the warm sun of May was a violent one. In their despair at seeing their fields hopelessly mowed down day after day, many "adapted their recollections to what they were then suffering," and proclaimed, by repeated statements, that the coming hatch would prove a failure. They had been misled into sowing a larger acreage than they would otherwise have sown. It was easy at that time to say that all writing upon the locust, and hence all entomological writing, was worse than useless. It may be said, on the other hand, that if farmers were misled in this matter they simply misled themselves, and that no statement was made on the subject of hatching by any one who had any better means of deciding the question than each man had in his own fields. Statements were made repeatedly in the country newspapers, in March and April, that attempts to hatch the eggs artificially had proved a failure, but there were just as many going to show that the eggs had not lost their vitality at all. Moreover, if there were any delusion in the matter, farmers in a large number of counties may rightfully claim that they were misled into a fear of sowing what would have proved the most successful wheat crop they have ever known.

DATES OF HATCHING.

Every year since the advent of the locusts in 1873 there have been reports of a certain amount of hatching in the fall. There is no point in the whole subject upon which there are more contradictory reports, and perhaps none on which observers are more likely to be misled. I have found the young of *femur-rubrum* quite thick in the last week of August, and of species of *Tragocephala* and *Stenobothrus* as late as the first week of October, but these latter never in large numbers. But reports, received from reliable sources, of locusts hatching numerously in September on the very spots where eggs had been laid by *spretus* early in the summer make it probable that a certain amount of hatching occurs in the fall. But I have never seen a fully-winged *spretus* so early in the spring as to make it necessary to suppose that it had survived the winter.

The earliest notice of hatching in the present year (whatever the species may have been) is to be found in the Saint Paul Pioneer Press: "Messrs. Hendryx and Newton, of the Farmers' Union, yesterday received a package of lively young grasshoppers, about half an inch long and evidently filled with an ambition to be a good deal longer. They were sent in by a farmer named Burch, residing at Vicksburg, Renville County. He writes under date of February 1, 'They are samples of our grasshoppers found this day, some on bluffs and some in the meadows.' He states that there had been at that date four warm days, and that, with the exception of occasional snow-drifts, the ground was then bare, and there were quite a number of those little hoppers, fully half an inch long, crawling about and impatiently waiting for the farmers to put in their seed." Similarly, the young were found in Nicollet, Blue Earth, Watonwan, and Yellow Medicine Counties during the month of February, generally about stony heaps of earth or on sandy bluffs. Specimens of these were received in February, and proved to belong to *Stenobothrus* and *Tragocephala*. The latter acquired wings during the first week in March. It is probable that all the young which appeared in February were native species, either just hatched or coming forth after hibernation; but all this was suspended during the cold weather in March.

Early in April (by the 10th) young locusts began to appear again in some of the southern counties, and by the 20th of the month considerable numbers had hatched out, particularly upon the bluffs along the Minnesota River between New Ulm and Saint Peter. The cold, cloudy weather, and the heavy snow which followed a week later, may have destroyed most of them; it is difficult to tell, as the young locust hides itself in such weather in crevices in the earth, among the roots and tufts of grass, and in everything on or near the earth that offers protection from the cold, and a day of warm sunlight brings them forth from unseen hiding-places in spots where they had before disappeared. Similarly, in 1875, both in northern and in southern counties, a large proportion of the early hatch of April disappeared after cold rains, and were perhaps destroyed. But if any were destroyed by the cold, above mentioned, it was but an insignificant portion of the whole number hatched during the season. If any favorable intervention of weather or temperature is to be sought for, it will be found not in a snow-storm at the end of April, which perhaps destroyed a comparatively

insignificant number of young locusts that would in any case have proved harmless for lack of sustenance, but in the character of the six weeks following. These were characterized by heavy rains, sometimes for several days in succession, interspersed with warm sunny days, up to the 14th of June, which closed a week of cold rains, with prevailing northwest winds. The results are a much more distributed hatching than usual, lasting from the 18th of April to the 1st of June; a large number of days when on account of cold and wet the locusts were obliged to forego eating, thus allowing the grain to recover to some extent from their previous ravages, or to make so much gain against future injury; and above all a luxuriant growth of wheat, which the young locust, loving warmth and light, was less inclined to enter, and which was so much the less vulnerable. It was common enough in June to see in wheat-fields spots where the wheat had sprung up thinly, which had served as starting points for the young locusts, and were eaten about the edges, while wherever the wheat grew thick and strong it was still untouched. Immunity has come not so much from the fact that the locusts were less in number or less able to injure, as from the fact that the grain was less capable of being injured. All this is a general statement of the case, and the fact that in certain countries the crops of whole fields, or even whole townships, have been swept away is no denial of the general truth. It is undeniable that where anything has been saved the damage has decreased as the season advanced, and that where anything like total destruction has occurred it has been in those localities where the damage was most serious before the 1st of June. Only such excessive numbers of locusts as have appeared in some of our worst infested counties could have caused a total destruction of the crops, and on the other hand the comparatively small numbers that appeared in other counties would have worked serious damage in a spring of a different character.

The following replies to circulars of the Entomological Commission denote "the dates when the eggs were most numerously hatching (in Minnesota) in the present year." The localities range from south to north by counties, according to the numbers:

1. *Bigelow, Nobles County.*—First hatch May 4th; most numerous hatch, May 15th and 16th. *Fairmont, Martin County.*—First saw them April 14th; they were reported a week earlier. Every fine day more or less hatch.

2. *Madelia, Watonwan County.*—Commenced hatching April 10, and have continued since, but most numerously between the 15th and 25th of May. The greatest amount hatched May 23.

3. *Severance, Sibley County.*—Between the 1st and 15th of May, and up to June 7th. *Hector, Renville County.*—From April 30 to May 24.

4. *Lac-qui-parle, Lac-qui-parle County.*—Between the 15th and 20th of May. *Kandiyohi, Kandiyohi County.*—Commenced on the last day of April and hatched in limited numbers in high and dry places until May 8 or 10; then in larger numbers till May 22. I notice a few hatching out to-day (May 25) in low places where the soil is moist and heavy.

5. *Morris, Stevens County.*—Between the 15th and 20th of May. *Otto, Pope County.*—A few hatched April 20. Between the 5th and 20th of May the weather was warm, with occasional light showers, and they came out in untold millions, and up to the present time (June 7) can be seen coming out.

6. *Elbow Lake, Grant County.*—Hatched on the 1st of May, and continued to hatch until the 20th; most of them from the 5th to the 10th. Some hatched as late as June 8th. *Alexandria, Douglas County.*—From May 15 to June 15.

7. *Audubon, Becker County.*—From May 10 to May 15. *Moorhead, Clay County.*—Very few before May 12; quite numerous by May 30. There was a heavy rain on the 25th, after which few survived.

In addition to these special statements, which are true for the particular localities which they represent, the columns of the local press throughout all the "grasshopper counties" show that by far the greater part of the hatching occurred later than the 1st of May. They also show that there was very little difference between northern and southern counties in regard to the date of hatching, and that the earliness of appearance of the young was determined more by the nature of the spots in which the eggs were laid than by any difference in latitude; at the most, there was not more than eight days' difference between Blue Earth and Otter Tail Counties.

LATE HATCHING.

The above statements in regard to the date of hatching apply mainly to those counties in which the eggs were deposited in July and the early part of August, 1876. But there are other counties, principally to the south of Saint Paul, and lying in or east of the Big Woods, where the eggs were deposited late in August, in September, and in some places in October. Here the locusts hatched not only in fewer numbers, but also later than elsewhere. This is at least partly due to the lateness of the deposit in the preceding year. Elsewhere the eggs laid by early and late comers were so mingled together that it was impossible to distinguish in the spring whether there was any

corresponding difference in the date of their hatching. But while it was possible in February to hatch artificially in thirty-six hours eggs received from the western counties, eggs from Morristown, Rice County (in a fluid state when received), were kept nearly three weeks in April before the young appeared. Reports from Carver, Rice, Waseca, Steele, and Freeborn Counties, on the 25th of May, showed that in almost every case the young were just beginning to appear, or that only a small portion of the eggs were as yet hatched. It may be added that in all these counties very little was heard of locusts beyond the mere fact of this late hatching, and that the damage resulting therefrom was but trifling.

Correspondents occasionally note the fact that eggs laid late in the season were correspondingly late in hatching. For example:

"PENN TOWNSHIP, MCLEOD COUNTY,
"*May* 24, 1877.

"These that are now hatched are the first laid-eggs, laid in the last week of July, 1876. The locusts staid about ten or twelve days and then left. The farmers then said that there were not eggs enough to do any hurt, and that they would put in their crops as usual. But in ten days others came, and kept coming, and staid six weeks, laying all the time. These last were young and smaller, and no doubt they made their first deposit of eggs here. These are the ones that have not yet hatched; they are in the liquid state yet.

"JACOB KOONS."

"LAKE PRAIRIE, NICOLLET COUNTY,
"*May* 30, 1877.

"Eggs deposited in the latter part of September are still unhatched.

"THOMAS HUGHES."

The following letter, published in the Waterford Gazette, Dakota County, in 1875, furnishes an account of a favorable opportunity of observing the exact dates of laying and hatching, which were both correspondingly late in the season;

"WATERFORD, *July* 8, 1875.

"On the 18th day of October, 1874, I noticed that grasshoppers had settled upon my farm in Waterford, covering an area not exceeding eight acres. During the last spring and present summer I have carefully watched for the appearance of young hoppers. I discovered none until June 20, 1875. On that day I discovered young hoppers in great numbers on the ground where the old hoppers settled last fall.

"W. A. GRAY."

The dampness of the season has also retarded hatching, and prolonged it to an extent not usual in other years. While almost every spring a very limited number of young locusts have been found making their appearance all through the month of June, the greater part of the hatching has generally occurred within a much briefer period than during the past spring; and wherever injury from the unfledged has proved to be serious, it is where the locusts were numerous by the last week of May. But the rain-fall of the past spring, coming as it did in many cases when the egg-pods were in the act of bursting, retarded the hatching, and in such places as retained moisture perhaps prevented it altogether. On the 27th of May I found at Montevideo, Chippewa County, a strip of loam, containing perhaps half an acre, where the hatching had begun in the early part of the month, and had been suddenly arrested by rain, and water standing upon the ground overnight. On digging up the egg-pods they were found to be spreading, the young having been arrested just as they were breaking the shell. The eggs appeared to be lifeless; but after lying in the warm sun for five minutes a portion of the young came forth, kicked off their surroundings, and hopped away. A large number of egg-pods, however, were found in a putrid condition, and these had freely attracted the *Anthomyia* larva, while the fly was observed on the vegetation close by. The eggs of the silky mite and some of the full-grown were found in the same spot. In this case only a limited amount of rain-fall had sufficed to effectually arrest hatching. It may be added that eggs plowed under in the spring in corn-ground remained unhatched until the 21st of June, and, when brought to the surface with a shovel-plow, were apparently lifeless, but hatched within an hour. In either case the locust was able to reach a certain point in the progress of hatching, and was stopped there. Finally, in cases where the ground has become hard by baking under the hot sun, a light rain-shower, followed by a warm sunlight, often seems to assist rather than to hinder hatching.

PROGRESS DURING THE SPRING.

By the 12th of May the young locust had appeared in immense numbers in the central part of the egg-area in those counties which have been already designated as most densely filled with eggs. These comprised a strip of country stretching southeastward from the central part of Otter Tail County to Lake Crystal, in Blue Earth

Country. On the east it terminated generally where the open prairie changed to woods, while on the west the limit was more irregular, including especially the tracts lying along the Upper Minnesota and its branches. The young appear to have come forth at once during the first ten days of May so numerously as in most cases to defy all efforts made to check them. In some cases, particularly in counties that had suffered in previous years, ditches were dug around fields at the outset, and everywhere great numbers were destroyed by straw spread around the hatching-grounds and fired. On the 18th of May the attention of the public was called to a new method of destroying the young, detailed in a letter to the Saint Paul Pioneer Press, dated May 17, and describing the coal-tar pan. The letter was written by Hon. A. B. Robbins, State senator from Willmar, Kandiyohi County, who made no claim whatever as an original invention, but who deserves all the credit of having forcibly brought to the notice of the people a principle which had been published several times before. The principle of the coal-tar pan had already been applied in Kansas, Colorado, and even in Minnesota, and mentioned in such a way that it ought by no means to have proved such a novel invention as it did. The New Ulm Herald, of May 28, 1875, had urged the use of coal-tar spread upon sheets of building-paper as a means of protecting grain-fields, and the same was referred to in full in the "Report to the Geological and Natural History Survey of Minnesota for 1876." Again, the Farmers' Union of Minneapolis, under the date of August 8, 1876, in a letter from Greeley, Colorado, had described the use of the same material, spread over stout canvas, fastened to a frame, to be dragged over the ground; while on page 51 of the "Report of the proceedings of the conference of governors at Omaha to consider the locust problem," the same machine was again described, with a notice of the use of zinc instead of canvas.

But the invention, when once brought to notice, gained favor at the outset. Mecker County summoned the county commissioners at once, and "determined to send for 250 barrels of coal-tar and 1,000 sheets of iron." Other counties took similar action, and for a time it was impossible to supply the materials fast enough. When tar was wanting, kerosene, molasses, ashes or sand moistened with kerosene, ashes and water, soft soap, or flour and water were used. The latter, when well filled with young locusts, was fed to the hogs. Tar was shipped over the different lines free of freight-charges, and the State provided a supply of 1,000 barrels to be distributed wherever it was needed.

In the last week of May I rode for about three hundred miles through some of the western counties and along the Upper Minnesota River. A portion of this trip included the northeastern part of Kandiyohi County, where, later in the season, the crops were almost totally destroyed. Here, on the 25th of May, the locusts had hardly begun to spread over the wheat-fields. They were at work upon the edges of the fields in immense numbers, and in a ride of about six miles across prairie and through woods the young were so numerous that they gave the impression, as they leaped up at every step, of heat flickering in the air. In many places the sand in the road was blackened for rods with the young basking in the sun, while the low bushes by the road-side had been trimmed bare. All these were still young, and had evidently moved but a short distance from where they were hatched. In some places they had already entered the grain fields in such numbers that in moving a distance of five rods the tar upon the tar-pan became so completely filled with the young that it would hold no more. But everywhere, over farms distributed all along the road, men, women, and children were bravely at work fighting as well as they could. In another direction, southwest of Willmar, and toward the Minnesota River, there was a different state of things. Here on a broad stretch of open prairie farms decreased in number on leaving the line of the railroad, and were situated miles apart in many cases. On leaving the thickly-settled portion, the locusts were found to be fewer and fewer in number, until out on the open prairie hardly a single locust was to be seen even where a patch of new breaking might have been expected to invite them in the previous laying season. This was an exact repetition of all that was learned last year, that in Minnesota it is only in the vicinity of cultivation, only near and among farms, that the locusts deposit their eggs. After a great deal of inquiry during the past summer, I have been able to learn of only one case where the young were found hatching at a distance of five miles from a cultivated field.

Between the 25th of May and the 1st of June I received reports from every county in which eggs had been laid, giving the condition of things up to that date. It was at that time impossible to estimate the damage that was likely to ensue, and while many counties which were afterward badly ravaged expressed a hope that the injury would be slight and could be averted by strenuous fighting, still other counties which in the end escaped unharmed were anxious for the future. Up to the middle of June a vigorous fight was kept up as long as there was any hope of saving a crop. By the 15th of the month, in the worst-infested towns, all crops were so nearly ruined that there was little left to fight for, while in others, where locusts had seemed numerous before, the weather and the efforts of the farmers combined had set the wheat so far ahead of the locusts that the crops were essentially saved.

It is impossible to say that all this warfare was pursued in the most intelligent man-

ner. While, by the last week of May, farmers were urging county and State authorities to hurry on supplies of tar and sheet-iron, the locusts were encroaching at their leisure upon the fields. A ditch around the fields at this time would not only have kept out the young until other means of fighting were supplied, but would have rendered other means unnecessary. Again, where the locusts were excessively numerous, the extent of field which could be protected with a single tar-pan was small, and as the locusts increased in size and activity, even this was daily lessened. When, in addition to this, the locusts were so extensively spread as to appear on all sides of a field at once, and *continued* to appear for three or four weeks, the tar-pan soon became useless. Still, in a large number of cases, the locusts were so thinned out by this method early in the season that what were left were afterward unable to make any serious impression on the luxuriant growth of grain, or, if they continued to be troublesome, were caught with drag-nets or other catching-machines. The simplest of these and the most efficient, in the latter part of June, when the locusts were large and the grain several inches high, was merely a wooden scoop, similar to a wagon-body with one of the sides removed. This, drawn over the grain, the open side foremost, at night, when the locusts were roosting on the grain-stalks, collected the pupæ in immense numbers, and, benumbed by the night air and dew, they rolled back into the trough and were soon piled together there in an inextricable mass, and could be disposed of at leisure. One farmer in McLeod County estimated that he had caught 400 bushels, another 800.

FIRST WINGED.

A single experiment tried during the spring gave exactly sixty days from hatching to full development of wings, on the 10th of June. As this was in confinement, possibly the time was somewhat longer than would have been required under natural circumstances. Taking sixty days as the time required for the full development of wings, locusts hatched on the 20th of April would become winged by the 19th of June, and this corresponds almost exactly with the dates at which a few locusts have begun to appear in the air every year since 1873. In fact, locusts, fully winged, have been found in the field every year at a still earlier date. In 1876 they were reported as early as May 26, but it may be doubted whether these were *spretus*. Last year I found winged *spretus* on the 8th of June, near Windom, and easily caught half a dozen in a few minutes. But it may be stated as a general rule that in the latitude of Mankato the larger portion of the locusts hatch in the first ten days of May and migrate in the first ten days of July. For the present year the earliest specimens of winged *spretus* were found in the fields about the 14th of June, and others were seen in the air at the same date, possibly from elsewhere. From the 14th of June onward the winged began to be noticed everywhere daily increasing in numbers, and had begun to move about in large bodies by the 26th of June. By the 10th of July far the greater portion had migrated, but there were still large numbers left in places, particularly in those counties where the eggs had been laid late in the fall preceding. The same is true of portions of Renville County. On the 6th of July, when the locusts had nearly all flown from the neighborhood of Glencoe, they were still at work upon the crops about Hutchinson, McLeod County. On passing through this region I found the locusts more numerous as I went westward, and on the 8th of July the locusts were found to remain still in Renville County, not only in excessive numbers, but at least two-thirds of them in the pupa stage. It seems difficult to account for this in any other way than by supposing that the eggs were laid later in the preceding fall.

It is impossible to tell how much value to attach to the various reports of locusts found dead in the fields. Early in the season such reports were generally traceable to finding the shells of the locusts, discarded in molting. While some correspondents state that next to none have been found dead, others report finding them in heaps, and so numerous as to create a stench in the air. I have hunted carefully through fields on every possible occasion to determine to what extent the locusts might be said to be dying from natural causes, and while large numbers of dead have been found, it was only an inconsiderable proportion of the whole. These were almost invariably pupæ, and I have seen them, at the thickest, lying at the rate of a dozen upon a square yard of earth. But considering how easily such slight things escape the eye, and how quickly they decay and disappear, the numbers noticed denote that a still greater number perished, and at least show that in respect to the effect of climate or degeneration, the past spring differs greatly from any that have preceded it.

But in regard to the locust in Minnesota the year differs from the four past years in nothing so much as in the character of the migrations. For four years past we have seen the locusts hatched here arise from their hatching-grounds and a part of them apparently settle down to lay eggs in adjoining counties, while others from abroad have added to their numbers later in the season, and the months of July and August have been a period of constant coupling and laying. But the flying of the present year has consisted almost entirely of migrations instead of mere change of base, and swarms have repeatedly crossed the State, only rarely alighting in such masses as to be destructive, alighting less frequently as the season advanced, and leaving behind them only trifling numbers of such as seem to have dropped through weakness or from the

burden of the parasites which they carried. These bodies, whether different armies, or one army changing its direction at different times, have swept across the State no less than six times, apparently passing entirely beyond our borders in each movement—

From July 3 to the 6th, northwesterly;

From July 8 to the 10th, southeasterly, apparently having turned at Morris, Breckinridge, and beyond;

July 11 and 12, northwesterly;

July 20 and 21, southeasterly;

July 28, again southeasterly;

August 1 and 2, again southeasterly;

And again in heavy but not widely extended flights to the southeast on the 7th, 8th, and 9th of August.

In the passage of July 3 to 6 the locusts alighted heavily and destructively; all later movements may be said to have been perfectly harmless as compared with previous years, while it has been almost impossible to learn of a single case of laying or preparing to lay. As in former years, the locusts in alighting have almost entirely avoided those localities where the young had been numerous in the spring.

STATISTICS OF DAMAGE.

The amount of losses resulting from locust ravages during the year 1877 has already been given, so far as it can be now ascertained, in the early part of this report. I have made no attempt whatever to gather the various guesses of farmers in the different ravaged townships as to what this loss would be in bushels. The experience of two years has shown that such estimates are far from accurate, and hence worthless. It is no easy matter for a farmer to estimate the exact loss on his own fields. When it comes to multiplying the error (almost always in excess) in a single town by several scores of townships, such estimates lose their value altogether. A far more important matter is the *amount left undestroyed*, and upon this point we have every reason to congratulate ourselves. We have learned, even without accurate statistical returns, enough to know already that our State has been blessed with a wheat crop certainly equal to and probably exceeding any ever before raised in the State; and this, too, notwithstanding the fact that future returns may perhaps show that more bushels have been destroyed than in any preceding year.

To those who are interested in learning the exact amount of injury caused by locusts to the four principal crops during the last four years, the following tables, compiled from the various reports of the commissioners of statistics of Minnesota, present as accurate statements as it is now possible to obtain:

Statistics of locust injury.

WHEAT.

	1873.	1874.	1875.	1876.
Total acreage of the State	1,548,713	1,681,830	1,764,109	1,873,891
Total yield, as reported, in bushels	26,402,485	23,938,172	30,079,360	18,224,357
Acres injured in the "grasshopper counties"	74,157	240,417	107,872½	250,460
Per cent. of State acreage injured	4.79	14.29	9.52	17.63
Bushels destroyed thereon	562,852	2,646,802	2,024,972	3,315,240
Total crop of the "grasshopper counties," including bushels destroyed	1,813,794	6,949,114	5,699,896	6,545,304
Loss per cent. of what would have been the whole crop in "grasshopper counties"	31.03	38.09	35.52	50.65
Loss per cent. of what would have been the whole crop of the State	2.09	9,96	6.31	15.4

OATS.

	1873.	1874.	1875.	1876.
Total acreage of the State	368,493	383,233	401,381	485,227
Total yield, as reported, in bushels	12,544,536	10,967,072	13,801,761	10,819,638
Acres injured in the "grasshopper counties"	14,079	62,125	38,560½	82,548
Per cent. of the State acreage injured	3.82	16.21	9.6	17.01
Bushels destroyed thereon	213,576	1,816,733	1,127,780	2,251,377
Total crop of the "grasshopper counties," including bushels destroyed	783,003	3,740,030	3,199,030	3,780,292
Loss per cent. of what would have been the total crop in the "grasshopper counties"	27.28	48.58	35.26	59.56
Loss per cent. of what would have been the total crop of the State	1.67	14.21	7.55	17.22

Statistics of locust injury—Continued.

BARLEY.

	1873.	1874.	1875.	1876.
Total acreage of the State	35,501	29,028	40,803	69,515
Total yield, as reported, in bushels	669,415	614,545	1,230,420	1,600,335
Acres injured in the "grasshopper counties"	.....	2,304	1,565¾	6,440
Per cent. of State acreage injured	.....	7.93	3.84	9.26
Bushels destroyed thereon	.....	58,962	41,059	159,368
Total crop of the "grasshopper counties," including bushels destroyed	.....	121,002	117,731½	309,090
Loss per cent. of what would have been the whole crop in the "grasshopper counties"	.....	48.73	34.87	51.56
Loss per cent. of what would have been the whole crop of the State	.....	8.75	3.23	9.06

CORN.

	1873.	1874.	1875.	1876.
Total acreage of the State	209,540	256,296	297,316	294,969
Total yield, as reported, in bushels	6,457,368	7,340,342	7,195,581	8,011,079
Acres injured in the "grasshopper counties"	8,368	34,139	52,755	55,211
Per cent of State acreage injured	4.	13.31	17.11	18.72
Bushels destroyed thereon	125,938	738,415	790,982	1,365,169
Total crop of the "grasshopper counties," including bushels destroyed	320,612	2,128,594	2,560,390	2,115,982
Loss per cent. of what would have been the whole crop in the "grasshopper counties"	39.28	34.69	30.89	61.68
Loss per cent. of what would have been the whole crop of the State	1.91	9.14	9.9	14.01

In regard to what are here termed the "grasshopper counties," not always the same from one year to another, the percentage of loss is at best only an *average* of injury, varying from an almost total loss of wheat in some counties to nearly a full crop in others. As it is impossible now to learn how much was harvested each year on the injured acreage, the showing is indefinite. Still it shows that certain counties have been deprived of an average of from 38 to 45 per cent. of their grain crops for four years in succession. This loss has fallen in a large measure upon a frontier community, just entering upon its pioneer existence, and forced by circumstances to depend mostly upon the very crops which were most liable to locust injury. Even in this universal struggle for existence, men have been able not only to maintain their footing, but in many cases to find profit in their venture, while a single harvest like that of the present year goes far to undo the losses of four preceding years.

But the percentage for the State as a whole is exact and definite. It shows that Minnesota has lost, from the years 1873 to 1876, inclusive, about 8½ per cent. of the wheat crop, 10 per cent. of the oat crop, 7 per cent. of the barley crop, and 9 per cent. of the corn crop, while at the worst only about 18 per cent. of its wheat acreage has ever been injured in any one year. This is a favorable comparison with other States in regard to locust injury, and more than favorable in comparison with States that have lost more from the chinch-bug in a single year than has been destroyed by all insects together in Minnesota since its settlement. Our unusual experience since 1873, unusual not only for Minnesota, but unusual in the history of any agricultural community, may not be repeated for centuries. At least it is certain that with a wider knowledge of the origin and nature of the evil, with enlarged resources, with more diversified industries, and with better facilities for meeting the various backsets that every grain-producing State must face sooner or later, the temporary presence of the locust in Minnesota will not, even in the near future, seem such a scourge to ourselves and a terror to others as the last five years have proved it.

Respectfully submitted.

ALLEN WHITMAN.

Professor CYRUS THOMAS,
United States Entomological Commission.

APPENDIX II.

NOTES ON THE NATURE OF THE FOOD OF THE BIRDS OF NEBRASKA.

By Prof. SAMUEL AUGHEY, *of Lincoln, Nebr.*

LETTERS OF TRANSMITTAL.

Prof. C. V. RILEY,
Chief of the United States Entomological Commission.

DEAR SIR: The chapter on "Vertebrate Enemies" having been assigned to me by the Commission, I have been fortunate in obtaining, by the consent of the Commission, the assistance of Prof. Samuel Aughey, of Lincoln, Neb., in this work. Having been engaged for a number of years in studying the birds of his State with special reference to their locust-eating habits, his report is quite full and complete, but is too long to be incorporated into the chapter assigned me. I have therefore, at the suggestion of the Commission, separated this portion, to be placed in the Appendix, the other portion being incorporated into and composing the greater portion of the chapter on "Vertebrate Enemies."

This record of the examination of the stomachs of birds is probably the most extensive ever made in this country. The list includes something over 630 specimens and 90 different species, and extends through a period of twelve years.

It develops very clearly the fact that in locust years these insects become the chief food of insect-eating birds, even the water-birds devouring them largely.

Very respectfully,

CYRUS THOMAS.

UNIVERSITY OF NEBRASKA,
Lincoln, Nebr., November 15, 1877.

DEAR SIR: At your request I have reduced to order the somewhat random notes that I have been taking on the birds of Nebraska and their relations to insect life, during the last thirteen years. Up to the present year my studies in this field have been pursued with no thought of a publication of results, but simply from a love for such pursuits, and hence my notes are not as complete as they otherwise would have been. It is owing to this that the exact day of the month of many of my dissections is not given. I could not attempt the supply of omissions of this kind in my notes from memory. I am under great obligations to Coues's* "KEY" and his "BIRDS OF THE NORTHWEST," as they enabled me, in the absence of other reference books, to identify some Western birds that were new to me. I have adopted his classification throughout. I could have doubled the number of insects found in the stomachs of birds by attempting an estimate of those embraced in the partially digested mass of matter, but the possibility of a mistake forbade the attempt. I regret that I have not been able to extend my investigations beyond Nebraska. Being convinced from my studies that the preservation of birds is worthy of national attention, I have added to these notes other facts and considerations showing the need of the enactment and the enforcement of laws to protect them.

SAMUEL AUGHEY.

Prof. CYRUS THOMAS,
United States Entomological Commission.

*At the request of Professor Riley, I have revised the nomenclature of the birds treated in this paper.—ELLIOTT COUES, *Washington, D. C.*, May 15, 1878.

Order PASSERES: Perchers.

Suborder OSCINES: Singing Birds.

Family TURDIDÆ: Thrushes.

TURDUS MIGRATORIUS, Linn.

Robin.

Not abundant in Nebraska, but slowly increasing. The following robins were killed to ascertain the character of their food, and especially the amount, if any, of locusts eaten:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.	Seeds, etc.
1	Dakota County, Nebraska	May 30, 1865	39	15	4
2	do	June 4, 1865	51	12	.....
3	do	June 6, 1865	54	9	.....
4	Burt County, Nebraska	June 9, 1867	17	27	7
5	Lancaster County, Nebraska	June 15, 1875	59	8	.....
6	do	June 14, 1877	54	13	.....

TURDUS MUSTELINUS, Gm.

Wood Thrush.

Abundant in all the wood lands of Eastern Nebraska. Killed none myself. Bought dead ones from boys.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	May 28, 1865	17	.....
2	do	June 10, 1865	21	.....
3	Lancaster County, Nebraska	Oct. 15, 1875	30	12

TURDUS PALLASI, Cab.

Hermit Thrush.

Have seen few of this species in Eastern Nebraska.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 6, 1865	19	16

TURDUS SWAINSONI, Cab.

Olive-backed Thrush.

Abundant in Eastern Nebraska. I regret that I have not distinguished the varieties.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Lancaster County, Nebraska	June 15, 1875	26	15
2	do	June 17, 1875	29	10

TURDUS FUSCESCENS, Steph.

Wilson's Thrush; Tawny Thrush; Veery.

Occasional in Nebraska, especially in the southeastern part of the State.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Richardson County, Nebraska	June 12, 1875	38	30
2	....do	....do	35	29

MIMUS POLYGLOTTUS, (L.) Boie.

Mockingbird.

Rare in Southern Nebraska; have not examined the stomachs of any, but had the good fortune of seeing a pair pick up locusts in the woods of Richardson County along the Nemaha River on the 12th of June, 1875.

MIMUS CAROLINENSIS, (Linn.) Gray.

Catbird.

Abundant in the woody portions of Nebraska, especially along streams of water.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 4, 1865	37	10
2	....do	June 6, 1865	31	12
3	Burt County, Nebraska	June 9, 1867	24	7
4	Lancaster County, Nebraska	June 15, 1875	40	9
5	....do	June 14, 1877	20	15

HARPORHYNCHUS RUFUS, (Linn.) Cab.

Sandy Mockingbird; Thrasher.

Abundant in Nebraska; have never examined the contents of their craws, but frequently observed them catching locusts in the spring of 1865 in Northern Nebraska, and also in Lancaster and Richardson Counties in the spring and summer of 1875.

SIALIA SIALIS, (Linn.) Hald.

Eastern Bluebird.

Abundant in Nebraska.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	May 29, 1865	18	10
2	....do	June 6, 1865	22	(*)
3	Lancaster County, Nebraska	June 15, 1875	27	8

*Undetermined.

Family SAXICOLIDÆ: STONE CHATS.

SIALIA ARCTICA, Sw.

Rocky Mountain Bluebird.

Have not observed it in Nebraska. In July, 1875, I saw it busily engaged in picking up locusts near Green River Station. I also observed it picking up locusts along the base of the Wasatch Mountains. Judging from these few instances, it must destroy large numbers of locusts.

Family SYLVIDÆ: SYLVIAS.

REGULUS CALENDULA, (Linn.) Licht.

Ruby-crowned Kinglet.

Only occasionally met with in Nebraska. Examined the stomach of only one.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 5, 1865	29	(*)

*Undetermined.

During the last season I also observed them feeding on locusts in Fremont, Nebraska.

REGULUS SATRAPA, Licht.

Golden-crested Kinglet.

Abundant during some years in Northern Nebraska. Have not seen them south of the Platte. In June, 1865, observed it picking up small locusts, east of Dakota City, in a sparse wood near the river.

Family CINCLIDÆ: DIPPERS; WATER OUZELS.

CINCLUS MEXICANUS, Sw.

Western Bluebird.

Rare in Nebraska. Seen it for the first time in August on the Niobrara, about seven miles from its mouth, in a dense timber. I was near enough to it to observe it catching locusts. Hon. J. Sterling Morton says that they are abundant in Otoe County.

POLIOPTILA CŒRULEA, (Linn.) Scl.

Blue-gray Gnat-catcher.

Found sparingly in Eastern Nebraska. On June 2, 1865, I opened the stomach of one near Dakota City. It contained a great number of the remains of small locusts. I watched one feeding in a spot where locusts of all sizes were abundant on June 14, 1875. With my field-glass I observed that it picked out the small ones. I observed the same phenomenon on June 2, south of Lincoln, Nebr. Judging from these few observations, this species selects the small locusts when it feeds on them.

Family PARIDÆ: TITMICE.

LOPHOPHANES BICOLOR, (Linn.) Bp.

Tufted Titmouse.

Abundant in Eastern Nebraska. Whenever the locusts were present, this bird seemed to live almost exclusively on them. The following specimens examined:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.	Seeds, etc.
1	Dakota County, Nebraska	May 30, 1865	67	3	A few seeds
2	....do	June 3, 1865	69	0	....do.
3	....do	June 8, 1865	64	5	....do.
4	Burt County, Nebraska	June 9, 1866	60	7	....do.

LOPHOPHANES INORNATUS, (Gamb.) Cass.

Plain-crested Titmouse.

Have seen none in Nebraska. In June, 1875, when at Cheyenne, Wyo., I was fortunate enough, some distance south of the town, to see a few. They were feeding on locusts and other insects, as I ascertained by watching them with my field-glass. Coues asserts that its habits are the same as the preceding, and if so it must destroy an immense number of locusts throughout the mountains.

PARUS ATRICAPILLUS SEPTENTRIONALIS, (Harr.) Allen.

Long-tailed Chickadee.

Very abundant in Eastern Nebraska. Feeds largely on locusts when they can be obtained. Have frequently watched them when feeding on these insects, and have examined the contents of the stomachs of the following:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 1, 1865	49	15
2	....do	... do	54	12
3	....do	June 6, 1865	57	6
4	....do	June 10, 1865	60	1
5	Lancaster County, Nebraska	June 8, 1875	52	7
6	....do	.... do	55	3
7	....do	June 15, 1875	48	2
8	....do	June 2, 1876	56	5
9	....do	June 14, 1877	50	2

Family SITTIDÆ: NUTHATCHES.

SITTA CAROLINENSIS ACULEATA, (Cass.) Allen.

Slender-billed Nuthatch.

Frequently met with in the timbered tracts of Eastern Nebraska, on the borders of which it can be found feeding on locusts when any exist.

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.	Grains or seeds.
1	Dixon County, Nebraska	May 29, 1865	25	3	4
2	Dakota County, Nebraska	May 30, 1865	21	4	7
3	Lancaster County, Nebraska	June 4, 1875	20	4	5
4	....do	June 13, 1877	27	5	0

SITTA CANADENSIS, Linn.

Red-bellied Nuthatch.

Only occasionally seen in the timber and along the edge of the timber in Northeastern Nebraska. Saw them eating locusts in Dakota County, Nebraska, and in Woodbury County, Iowa, in June, 1865.

SITTA PYGMÆA, Vig.

Met this bird for the first time this season in Nebraska. It was in the timbered bottom and bluffs of the Niobrara River, on the northern border of the State. I did not observe it feeding, neither did I succeed in capturing a specimen for examination, but suspect, from the observed practice of its congeners, that it also feasts on locusts when an opportunity offers.

Family CERTHIIDÆ: CREEPERS.

CERTHIA FAMILIARIS, Linn.

Brown Creeper.

Found a nest of this bird in a knot-hole, in the timber, near Dakota City. The parents sometimes brought young locusts for food to their young. This is the only evidence that I have that this species feeds on them. I took my position near the nest, and watched the old birds with a glass by the hour. In one hour they brought 27 locusts that I could distinguish to their young. This was in June, 1865.

Family TROGLODYTIDÆ: WRENS.

SALPINCTES OBSOLETUS, (Say) Cab.

Rock Wren.

Frequent in Nebraska. On June 3, 1865, found a nest near Dakota City, Nebr., in an old slab pile. June 10 I watched the parents from a few feet distant for an hour, and during this time among other insects they brought 32 small locusts to their young. In June, 1875, also found a nest in an old stump on Salt Creek, and observed the parents feed their young with small locusts. I also learned from Hon. J. Sterling Morton that he often saw them eat locusts.

THRYOTHORUS LUDOVICIANUS, (Lath.) Bp.

Great Carolina Wren.

Only saw it once in Nebraska. This was in Richardson County, Nebraska, June 12, 1875. One of the parents had a locust in its bill, probably for its young, but I hunted in vain for its nest in the thick wood. This is the most southeasterly county in the State.

THRYOTHORUS BEWICKI, (Aud.) Bp.

Bewick's Wren.

Found one nest of this species near the Missouri River, in Otoe County. This was June 12, 1875. The parents here were also feeding their young with small locusts, but I did not, from lack of time, ascertain how many they brought in an hour.

TROGLODYTES AËDON, Vieill.

House Wren.

This species is abundant in Nebraska. I have watched the parents feeding their young in a great number of instances in Northern and Southern Nebraska and in Western Iowa during locust years, and always found them bringing a great number of small locusts to their nests. This was especially noticeable during the early part of the season. I have rarely observed a house wren capture a full-grown locust, but why I have not ascertained.

TROGLODYTES AËDON PARKMANNI, (Aud.) Coues.

Western House Wren.

This wren, like the preceding, is abundant in Nebraska, and like it feeds its young on young locusts. This I have observed it to do in many instances.

ANORTHURA TROGLODYTES HYEMALIS, (Vieill.) Coues.

Water Wren.

Only occasionally met with in Nebraska. I have never found its nest, but I examined a dead one in June, 1875, which had been killed near Lincoln. It had 13 small locusts in its craw.

TELMATODYTES PALUSTRIS, (Wils.) Bd.

Long-billed Marsh Wren.

Only occasionally met with in the marshes along the Missouri. In June, 1875, I found a nest on the edge of a marsh near Bellevue on the Burlington and Missouri River Railroad. Watching the nest I found the parents bringing young locusts, but not seeing any of these insects near the marsh, I was at first puzzled to know where they obtained them. Watching them more closely with my field-glass, I soon observed them to fly to the dry bluffs an eighth of a mile distant, and bring back small locusts. This seemed to me all the more curious as there was an abundance of small insects closer at hand. In one hour they brought 31 locusts to their nest.

CISTOTHORUS STELLARIS, (Licht.) Cab.

Short-billed Marsh Wren.

Found only one nest of this bird in 1867 in a swamp or marsh in Dixon County, Nebraska, in the Missouri Bottom. Did not ascertain whether it fed on locusts, and only suspect that it does from the habits of its congeners. It is only occasionally met with in Nebraska.

Family ALAUDIDÆ: LARKS.

EREMOPHILA ALPESTRIS, (Forst.) Boie.

Horned Lark; Shore Lark.

Some seasons quite abundant in Eastern Nebraska. Saw them picking up locusts in Dakota County, Nebraska, in the early part of June, 1865. On the 20th of May, 1875,

I found a nest close to the lower edge of a bluff north of Cropsy's mill, two miles from Lincoln Nebr. The young were already hatched out; taking as near a position as I could, I watched the old birds feeding their young, on two days. The locusts were yet comparatively small, and I could not tell even with my field-glass the character of the food with any certainty, but concluded, as they flew to a spot which was covered with locusts, for food, that they must be dining on them. On June 16 I shot one, and found in its stomach 42 locusts and 33 small seeds. The variety was *leucolæma* of Coues.

Family MOTACILLIDÆ: WAGTAILS.

ANTHUS LUDOVICIANUS, (Gm.) Licht.

Titlark; Pipit; Wagtail.

Only a few pass north through Eastern Nebraska during the last of April. They return in September. I examined the following in September, 1874. The migratory locusts had reached and laid their eggs at this time:

Number.	Locality.	Date.	Locusts in the stomach.	Other Insects.
1	Lancaster County, Nebraska	Sept. 20, 1874	43	5 and some grains
2	....do	....do	51	2 and some grains.
3	....do	Sept. 25, 1874	49	7 and some grains.

Family SYLVICOLIDÆ: AMERICAN WARBLERS.

MNIOTILTA VARIA, (Linn.) Vieill.

Black-and-white Creeping Warbler.

Have only seen this bird in the wooded sections of Nebraska. Found a nest a few miles south of Lincoln on the ground, at the edge of a strip of timber. Unfortunately, I lost the exact date, but it was some time during the month of May, 1875. I watched the old feeding the young, but could not determine exactly what kind of food they brought them, but concluded it must be young locusts in part, as they flew from their nests to some old breaking near by, which was covered with young locusts just hatching out. They flew to this old breaking and back to their nests with food every few minutes. On June 5 I examined the stomach of one, that held 41 locusts, 12 other insects, and a few seeds.

PARULA AMERICANA, (Linn.) Bp.

Blue Yellow-backed Warbler.

It reaches Nebraska about the 1st of May, and is found principally along timber belts and in orchards. I have frequently seen the young soon after leaving the nest, but the nest itself I have never found. Have never examined the contents of their stomachs, but have frequently seen them picking up locusts and other insects. Of locusts they must consume large numbers.

PROTONOTARIA CITREA, (Bodd.) Bd.

Prothonotary Warbler.

Have only seen this bird a few times in Southeastern Nebraska, in Richardson County. There, in June, 1875, I observed it picking up locusts at the edge of a belt of timber.

HELMITHERUS VERMIVORUS, (Gm.) Bp.

Worm-eating Warbler.

Like the last, have only seen this species in the southeastern part of the State. There, in June, 1875, observed it feeding on locusts. Did not find its nests nor see its young.

HELMINTHOPHAGA PINÛS, (Linn.) Bd.

Blue-winged Yellow Warbler.

This species also only appears in the southeastern part of the State. Do not know whether it breeds within our borders. I have observed it but once feeding on locusts, in June, 1875, at the border of some timber, near the mouth of the Nemaha River.

HELMINTHOPHAGA CHRYSOPTERA, (Linn.) Cab.

Blue Golden-winged Warbler.

Occasionally seen in Eastern Nebraska, but have not met with it during our locust years. Judging from the known characters of its congeners, it must also prey on these inseets.

HELMINTHOPHAGA RUFICAPILLA, (Wils.) Bd.

Nashville Warbler.

This bird arrives in Eastern Nebraska about May 1, and some seasons at least breeds in and on the borders of the timber belts. On June 10, 1865, I found a young one that had just left the nest and flew with difficulty. As it was alone, I killed it to find the contents of its stomach. It contained 21 locusts and a few other insects. The nests I have never found. I, during the same month, frequently saw old birds feed on locusts. The birds, owing to their small size, were hard to watch, except at the edge of the timber, where it was sparse.

HELMINTHOPHAGA VIRGINIÆ, Bd.

Virginia's Warbler.

Have only seen one specimen of this bird in Southwestern Nebraska in a narrow belt of timber in the Republican River Bottom, in Hitchcock County. Know nothing from observation of its habits, but suppose, from the known character of its congeners, that it also feeds on locusts.

HELMINTHOPHAGA PEREGRINA, (Wils.) Cab.

Tennessee Warbler.

Occurs sparingly in Eastern Nebraska in the latter part of May, as it is moving north. In June, 1865, I observed them flitting among the tree-tops in a timber south of Dakota City. One evening, at the edge of the timber, half a dozen of them toward evening lighted on the ground about two rods from me, where the soil was covered with young locusts. With my field-glass I could distinctly see the birds pick up the locusts. I never found any indications of their breeding in this State.

DENDRŒCA ÆSTIVA, (Gm.) Bd.

Blue-eyed Yellow Warbler; Golden Warbler; Summer Warbler.

Abundant in Nebraska.

This bird has exhibited characters in relation to the locusts different from any that I have thus far referred to, as the following examples show:

Number.	Locality.	Date.	Locusts in the craw.	Other insects.
1	Dakota County, Nebraska	June 5, 1865	10	27
2	....do	....do	13	21
3	....do	....do	12	24
4	Lancaster County, Nebraska	June 12, 1875	8	30
5	....do	....do	14	19
6	....do	June 14, 1877	9	30
7	....do	....do	11	25

DENDRŒCA VIRENS, (Gm.) Bd.

Black-throated Green Warbler.

Have only noticed this species along timber belts in Eastern Nebraska during its migrations northward. The following were examined:

Number.	Locality.	Date.	Locusts in the craw.	Other insects.
1	Dakota County, Nebraska	June 5, 1865	21	20
2	....do	June 6, 1865	27	15
3	....do	....do	24	20
4	Lancaster County, Nebraska	June 14, 1875	22	22
5	....do	....do	22	27

DENDRŒCA CŒRULESCENS, (Linn.) Bd.

Black-throated Green Warbler.

Is present in spring and fall during its migrations in Eastern Nebraska, but sparingly. Shot one in September, 1874, near Lincoln, Nebr., which had 23 locusts in its craw and 15 other insects. Found no traces of its breeding in the State.

DENDRŒCA CŒRULEA, (Wils.) Bd.

Cœrulean Warbler.

Abundant in Eastern Nebraska along the wooded river-bottoms, where it is in the habit of breeding. All the nests (six) that I have found in thirteen years in Nebraska, were built in plum-bushes, from two to four feet from the ground. One such I watched near Pilgrim Hill, in Dakota County, Nebraska, in June, 1865. The parents every few minutes brought a locust to their young. I saw them picking them up, with my field-glass, and carrying them to their nests. An old field, a hundred yards distant from their nest in a plum-grove, gave them excellent feeding-grounds.

DENDRŒCA CORONATA, (Linn.) Gray.

Yellow-rump Warbler.

Have seen young birds in Eastern Nebraska on several occasions, but have failed to find the nests. It is frequently seen along our timber belts. Examined the craw of one in June, 1875, that contained 31 locusts and 5 other insects. In June of the present year, observed one picking up locusts on the Antelope Bottom. Observed the operation carefully with my field-glass.

DENDRŒCA BLACKBURNIÆ, (Gm.) Bd.

Blackburnian Warbler.

Occasionally seen in the borders of woodlands in Eastern Nebraska. Have as yet found no traces of its breeding here, and made no observations on its feeding habits. I conclude, however, from the character of its congeners, that it must also feed on the locusts.

DENDRŒCA STRIATA, (Forst.) Bd.

Black-poll Warbler.

Rather common in Eastern Nebraska during its migrations toward the north. Found no traces of its breeding here. The following were examined for locusts:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 5, 1865	37	7
2	....do	....do	29	15
3	Lancaster County, Nebraska	June 14, 1875	27	14
4	.....do	June 13, 1875	30	11

DENDRŒCA CASTANEA, (Wils.) Bd.

Bay-breasted Warbler

Occasionally met with in Eastern Nebraska, but found no indications of its breeding here. Shot one specimen in September, 1874. Found 19 locusts and 22 other insects in its stomach.

DENDRŒCA PENNSYLVANICA, (Linn.) Bd.

Chestnut-sided Warbler.

Rather common in Eastern Nebraska during its migrations. No indications of its breeding here. Shot one in September, 1874, and found 17 locusts and 21 other insects in its stomach.

DENDRŒCA MACULOSA, (Gm.) Bd.

Black-and-yellow Warbler.

Occasionally seen on its migrations in Northeastern Nebraska. In May, 1865, examined the craw of one near Ponca, Dixon County, Nebr. It contained 23 locusts and 17 other insects.

DENDRŒCA DISCOLOR, (Vieill.) Bd.

Prairie Warbler.

Abundant in Eastern Nebraska, where it breeds. I have seen the young in Dakota County, and found one nest in Richardson County, near the Nemaha, in a papaw bush, four and a half feet from the ground. It was in a fork. It differs much apparently in the number of locusts it feeds on between spring and fall. During the latter season it probably captures them on the wing, and that may account for the difference. The following is my list of examinations:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 1, 1865	8	20
2	do	do	10	17
3	Lancaster County, Nebraska	Sept. 5, 1874	22	8
4	do	Sept. 20, 1874	27	5
5	do	June 2, 1875	10	28
6	do	June 14, 1875	12	20
7	do	June 4, 1877	14	18
8	do	do	13	23

DENDRŒCA DOMINICA, (Linn.) Bd.

Yellow-throated Warbler.

Have only seen this species in Southeastern Nebraska, along the Nemaha, where it is belted with timber. I examined but one individual in September, 1874. It had 15 locusts and 24 other insects in its stomach.

DENDRŒCA PALMARUM, (Gm.) Bd.

Yellow Red-poll Warbler.

Abundant in Eastern Nebraska in early spring while passing north, and also in late autumn while migrating south. Does not breed in the State. Shot one April 10, 1875, which had a large number of locust eggs in its craw; how many I could not estimate. How it obtained them is a mystery to me, unless it lit down where the wind had laid them bare, or where some farmer had exposed them by harrowing. I also shot one on October 1, 1876. It had 16 locusts and some other insects in its stomach.

DENDRŒCA PINÛS, (Wils.) Bd.

Pine-creeping Warbler.

Like the preceding, passes through Nebraska in early spring, and loiters here in autumn. And what is curious, in looking over my notes I find that I noted finding locust eggs in its craw in April, 1865, in Dakota County, Nebraska, and in April, 1875, and 1877, in Lancaster County, Nebraska. Examined one September 30, 1876, which contained 11 locusts in its stomach.

SIURUS AURICAPILLUS, (Linn.) Sw.

Golden-crowned Thrush; Orange-crowned Accentor.

Ten years ago this bird was rather abundant in Eastern Nebraska in and on the borders of timber belts. During the last few years, it has been less frequently seen, until the present season, when it once more became somewhat abundant. It breeds in the State. Reaches here the second and third week in April. The following is the result of my examinations:

Number.	Locality.	Date.	Locusts in the stomach.	Locust eggs.	Other insects.
1	Dakota County, Nebraska	April 20, 1865	.....	A large mass.	21
2	do	April 22, 1865	.....	do	30
3	do	June 3, 1865	27	.....	21
4	Lancaster County, Nebraska	June 13, 1875	40	.....	9
5	do	April 12, 1877	.....	A large mass.	4
6	do	June 10, 1877	43	A few	8

SIURUS NÆVIUS, (Bodd.) Coues.

Water Thrush.

Occasionally met with in Northeastern Nebraska, where, near Ponca, Dixon County, I found the young, but never saw the nest. This was in 1865. In the same month, June, I killed one near a slough, among some thickets. It had 19 locusts and 20 other insects in its craw.

SIURUS MOTACILLA, (Vieill.) Bp.

Large-billed Water Thrush.

Have seen this bird only in Southeastern Nebraska, in the timber along the Nemaha, near its mouth. Examined one specimen only, in June, 1875. It contained in its craw 13 locusts and 37 other insects. Have seen no sign of its breeding here.

OPORORNIS FORMOSA, (Wils.) Bd.

Kentucky Warbler.

This bird is rather common in Southeastern Nebraska, especially in the Missouri Bottom and along the Nemaha. As I was sitting at the edge of this stream in June, 1875, near its mouth, where there are many bushes, I observed one of these birds at the water's edge picking up some locusts that had jumped into the water. After it had taken its fill it flew to a neighboring bush and chirped. I afterward shot one, but found only nine locusts in its throat, but a large number of insects, which appeared to me under a microscope to be spiders. It breeds in this portion of the State. I found no nest, but saw the young on several occasions.

GEOTHLYPIS TRICHAS, (Linn.) Cab.

Maryland Yellow-throat.

Common in Nebraska and breeds here. I watched the old birds feed their young at the edge of the timber and brush south of Dakota City, in June, 1865, and along Salt Creek, near Lincoln, in June, 1875. In both cases the old birds brought small locusts to their young. To make sure of this I took one of the young from the nest and found eight distinguishable small locusts in its stomach.

GEOTHLYPIS PHILADELPHIA, (Wils.) Bd.

Mourning Warbler.

Found in Eastern Nebraska, and breeds in at least the southeastern part of the State, where I once saw the old birds feed the young that had left the nest, though the latter I never succeeded in finding. I never ascertained positively whether it fed on locusts, but suppose that it does from the known characters of its congeners.

GEOTHLYPIS MACGILLIVRAYI, (Aud.) Bd.

Macgillivray's Warbler.

Have only seen this variety in Western Nebraska, and am uncertain whether it breeds here. In the latter part of August, 1874, while wandering along the river with Mr. D. W. Smith and Mr. Hungerford, I had the pleasure of seeing this bird capture some locusts that were flying at the time, while on the wing. This is my only observation on this bird in relation to the locusts.

ICTERIA VIRENS, (Linn.) Bd.

Yellow-breasted Chat.

Found over the greater part of Nebraska, and breeding in at least the eastern part of the State. In September, 1874, and September, 1876, I observed them capture locusts on the wing, and there can be no doubt that they destroy large numbers of them.

I have not been able to distinguish between the type-species and var. *longicauda*, to which Coues refers, and am not sure therefore which form I observed, but probably the latter.

MYIODIOCTES MITRATUS, (Gm.) Aud.

Hooded Flycatching Warbler.

Occurs in Southeastern Nebraska, where I observed it along the Nemaha River. Here I, on several occasions in September, 1874, admired the quickness and skill with which they captured locusts on the wing. Nothing appeared to me to be so adroit as to see this flycatcher, with the apparent quickness of lightning, gobble up the locusts that rose in the air.

MYIODIOCTES PUSILLUS, (Wils.) Bp.

Wilson's Green Black-capped Flycatching Warbler.

Met sparingly in both Eastern and Western Nebraska. Do not know whether it breeds in the State. Observed it capture locusts on the wing in the last of August, 1874, on the Republican River, in Southwestern Nebraska.

MYIODIOCTES CANADENSIS, (Linn.) Aud.

Canadian Flycatching Warbler.

Have observed this bird only during the spring migrations and in the eastern part of Nebraska. The single one that I killed in Richardson County close by the Nemaha had 5 locusts and 29 other insects in its craw. This was in the middle of May, 1875. Have not seen any indication of it breeding in the State.

SETOPHAGA RUTICILLA, (Linn.) Sw.

Redstart.

Common in the timbered river-bottoms of Nebraska, and breeding extensively. The following were examined, to ascertain their characteristic food:

Number.	Locality.	Date.	Locusts in the craw.	Other insects.
1	Dakota County, Nebraska	May 30, 1865	10	31
2	....do	June 3, 1865	15	27
3	....do	June 11, 1865	29	8
4	Lancaster County, Nebraska	June 5, 1875	21	29
5	....do	June 10, 1875	28	13
6	....do	June 15, 1875	20	14
7	....do	June 17, 1875	38	2

Family TANAGRIDÆ: TANAGERS.

PYRANGA RUBRA, (Linn.) Vieill.

Scarlet Tanager.

Have seen this bird only in Southeastern Nebraska, in Nemaha and Richardson Counties. It was most abundant along the Nemaha River, where I found it breeding in 1875. In the autumn of 1874, I shot one that had 37 locusts in its craw, and nothing else that I could identify.

PYRANGA ÆSTIVA, (Gm.) Vieill.

Summer Redbird.

This bird I have also only observed in the southeastern part of the State along the Nemaha River. Have not discovered any breeding in the State, but they probably do. I have not ascertained anything concerning its food, but like its congeners it probably feeds on locusts when it can get them. I did not distinguish between this form and the variety *cooperi*, which probably is not represented here.

PYRANGA LUDOVICIANA, (Wils.) Bp.

Louisiana Tanager.

Have not met with this bird anywhere in Nebraska, and only introduce it here because in July, 1875, when in Utah, I bought one from a boy, who had shot it in the Wasatch Mountains. Its stomach contained 13 locusts and an indefinite number of *Coleoptera* that I could not identify.

As this bird has been identified by Mr. Allen in Western Kansas (Coues, Birds of the Northwest), it will probably yet be found on the high plains of Western Nebraska.

Family HIRUNDINIDÆ: SWALLOWS.

HIRUNDO ERYTHROGASTRA, Bodd.

American Barn Swallow.

Occurs in various localities in eastern Nebraska, and also breeds here. I have observed more of them in Otoe County than anywhere else. I doubt whether they

capture many locusts until they begin to fly. The following examinations seem to prove this:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	June 1, 1865	4	37
2	....do	June 17, 1865	34	6
3	Lancaster County, Nebraska	May 28, 1875	2	40
4	....do	June 5, 1875	10	33
5	....do	June 16, 1875	37	4
6	....do	....do	34	3
7	....do	June 14, 1877	18	12

This list seems to indicate that this swallow captures locusts principally on the wing.

TACHYCINETA BICOLOR, (Vieill.) Cab.

White-bellied Swallow.

This bird is found but rarely in Nebraska. Why it is so seldom found here I am unable to tell. I have heard of its breeding here, but have seen no nests or young. I only believe it to feed on the locusts from the habits of its congeners.

TACHYCINETA THALASSINA, (Sw.) Cab.

Violet-green Swallow.

Have only met this swallow in Western Nebraska, where I found it nesting in 1875 in crannies in exposed Miocene rocks near Pine Bluffs, and in similar rocks the year previous in the upper portion of the Republican Valley. In the latter portion of August, on the Republican, I shot one which contained 23 locusts and 17 other insects in its stomach.

PETROCHELIDON LUNIFRONS, (Say) Scl.

Cliff Swallow; Eave Swallow.

Occurs in Eastern Nebraska in great numbers, where it breeds both on the sides of cliffs and under the eaves of houses. Hayden has observed the great number of this species along the Missouri and the vast number of nests on the vertical sides of the river-bluffs, especially of the chalk bluffs near Niobrara. I had the opportunity of observing the same phenomenon at Niobrara during August of this year. Three miles east of the town, on the sides of a perpendicular chalk rock (Cretaceous No. 3 of Hayden), I counted 2,100 nests of this bird. I saw other points where there were almost as many. They destroy countless numbers of locusts and other insects. The following is the result of my examination of their feeding habits:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	May 30, 1865	10	33
2	....do	June 6, 1865	21	17
3	Burt County, Nebraska	June 9, 1867	29	13
4	Lancaster County, Nebraska	June 1, 1875	7	55
5	....do	June 14, 1875	39	4
6	....do	....do	47	0
7	....do	June 16, 1877	49	2
8	....do	....do	44	8

From this list it is also evident that this swallow waits until it can capture the locusts on the wing before it indulges extensively in such exquisite bird food.

COTYLE RIPARIA, (Linn.) Boie.

Bank Swallow.

Common in Eastern Nebraska, though not as abundant as the preceding. In the spring of 1865 (but the exact date I cannot decipher from my old notes), I watched

some old birds feeding their young at the edge of a high bluff formed by the Loess deposits. With my field-glass I could distinctly see the old birds bring their young, among other insects, a good many small locusts. The following examinations proved a similar habit to the preceding:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dixon County, Nebraska	May 28, 1865	4	39
2	....do....	....do....	7	34
3	Dakota County, Nebraska	June 5, 1865	14	26
4	Cass County, Nebraska	June 17, 1875	39	4
5	....do....	....do....	40	5

STELGIDOPTERYX SERRIPENNIS, (Aud.) Bd.

Rough-winged Swallow.

Found this species breeding in Richardson County, along the Missouri bluffs, where it burrowed like the bank swallow. It was few in numbers, and I have not noticed it elsewhere in Nebraska. Have made no examination of its stomach, but have no doubt, from the habits of its congeners, that it devours locusts when it can obtain them.

PROGNE PURPUREA, (Linn.) Boie.

Purple Martin.

Rather common in Nebraska, where it breeds. This swallow, more generally than any of the others, captures locusts at all stages of their growth; at least this was my observation from the following few that I examined:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects.
1	Dakota County, Nebraska	May 27, 1865	17	25
2	....do....	June 5, 1865	28	15
3	....do....	June 12, 1865	30	16
4	Burt County, Nebraska	June 9, 1867	32	12
5	Dakota County, Nebraska	June 7, 1868	9	31
6	....do....	....do....	12	29
7	Lancaster County, Nebraska	June 2, 1875	27	13
8	....do....	June 16, 1875	32	12
9	....do....	June 16, 1875	38	6
10	....do....	....do....	40	2

Though there were no migratory locusts present to an appreciable amount in Dakota County in 1868, there were many of the *Caloptenus femur-rubrum* and other species of grasshoppers, and from that source the swallows examined that year and given above must have obtained its food, or a portion of it.

Family AMPELIDÆ: WAXWINGS.

AMPELIS GARRULUS, Linn.

Bohemian Waxwing.

Rare in Nebraska in winter. Have seen it but twice in the State. The first time was in February, 1865, when I secured a specimen. Its stomach contained an immense number of locust eggs, which it must have obtained at some point where the wind had laid them bare. At the time I did not know what they were, as it was my first experience in Nebraska; but they were identified for me by Mr. Graff.

AMPELIS CEDRORUM, (Vieill.) Gray.

Cedar-bird; Cherry-bird; Carolina Waxwing.

Have seen flocks of this bird only a few times in Nebraska, and it must be rare here. Found it breeding once near Nebraska City, where, in June, 1875, I obtained one specimen. Its stomach contained 17 locusts and a large number of seeds and grains.

MYIADESTES TOWNSENDI, (Aud.) Cab.

Townsend's Flycatching Thrush.

This bird must be accidental in Nebraska. I learned to know it in the mountains from Coues's description. During the last summer, in August, I was astonished to see one on the Niobrara, among some cedars. After watching it for some time, with the skill of a fly-catcher it captured a locust, on the wing, as a few of these insects were flying at the time. It is the only time I have ever seen it in the State, and have learned nothing as to the proportion of locusts that they capture.

Family VIREONIDÆ: GREENLETS.

VIREO OLIVACEUS, (Linn.) Vieill.

Red-eyed Vireo.

This Vireo is common in the timber belts along the Missouri and its tributaries in Nebraska. It breeds abundantly in the State. At the edge of timber I have frequently seen it emerge from a thicket and light down on locust-covered ground, and fill itself, especially when these insects are half-grown. I have been disappointod in killing these birds late in June, both in Dakota County in 1865, and in Lancaster County in 1875, and finding only the remains of a few locusts, while a month earlier four-fifths of their food was made up of these insects.

VIREO PHILADELPHICUS, Cass.

Brotherly-love Vireo.

Common in Eastern Nebraska, but not as abundant as the preceding species. It also breeds here, and like the foregoing, when it first arrives, from the 15th to the 25th of May it indulges more in locust food than a month later, when they are larger. The following record is indicative of this:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	May 27, 1865	19	15
2	..... do	June 5, 1865	21	10
3	..... do	June 17, 1865	2	22
4	Lancaster County, Nebraska	June 16, 1877	5	20

VIREO GILVUS, (Vieill.) Bp.

Warbling Vireo.

Have only found this species abundant in Northeastern Nebraska, where it breeded. A great many nests of this bird were built among the cottonwoods in Dakota City, where, in May and June, 1865, I frequently saw it light down within a rod of me where locusts abounded and feed on them. This species seemed to eat them in all stages of their growth, and brought them constantly to their nests for their young.

VIREO FLAVIFRONS, Vieill.

Yellow-throated Vireo.

Somewhat abundant in Southeastern Nebraska, but rare north of the Platte. It breeds in Richardson County. I have failed to make any observations with reference to the feeding habits of this bird, but have no doubt, from the character of its congeners, that it also eats young locusts.

VIREO SOLITARIUS, (Wils.) Vieill.

Blue-headed or Solitary Vireo.

Found in the timber-belts of Eastern Nebraska, but not abundant. The only one whose stomach I examined, in June, 1865, contained about an equal quantity of locusts and other insects.

VIREO NOVEBORACENSIS, (Gm.) Bp.

White-eyed Vireo.

Occasionally met with in Nebraska, where, in Richardson County, in some shrubbery in the Nemaha Bottom, I found a nest in the spring of 1875. The old birds were feed-

ing their young with locusts. In watching them with a glass from the forks of a cottonwood near by, I observed the old birds tear a large locust in pieces, and give it to their young in sections

VIREO BELLI, Aud.

Bell's Vireo.

This bird is sparingly present in Nebraska, but not as abundant as Coues found it in Kansas. It breeds along the Missouri bottoms and some of the tributaries of this river I have made no observations on its feeding habits, and only suppose that it also feeds on locusts from the habits of its congeners.

Family LANIIDÆ: SHRIKES.

COLLURIO BOREALIS, (Vieill.) Bd.

Butcher-bird; Northern Shrike.

I have not observed this bird in Nebraska until the fall of the year, when it occurs sparingly. In the fall of 1874, in the last days of September, when I was wandering along the Nemaha, in Southeastern Nebraska, I noticed a thorn-bush, on which was impaled a vireo and eleven locusts, some of which were fresh. After watching it for an hour from a distance, a butcher-bird appeared with another locust, which it impaled and then flew off. I afterward shot one, but its stomach contained only fourteen locusts, although there were immense numbers of them flying at the time and laying their eggs here. I did not subsequently succeed in determining the proportion of locusts that this bird consumed for food.

COLLURIO LUDOVICIANUS EXCUBITOROIDES, (Sw.) Coues.

White-rumped Shrike.

Rather abundant in Nebraska. I saw the young in the Missouri Bottom, in Dakota County, in 1867, and on the Niobrara in 1869. The following were examined:

Number.	Locality.	Date.	Locusts in the stomach.	Other insects or birds.
1	Dakota County, Nebraska	June 17, 1865	27	Portions of a bird.
2	Richardson County, Nebraska	Sept. 28, 1874	37	....do.
3	Lancaster County, Nebraska	June 17, 1875	32	....do.

Family FRINGILLIDÆ: FINCHES, ETC.

This entire family being granivorous—seed-eaters—bud- and fruit-eaters, I have not examined them so closely as the preceding forms. And yet most of them will, on more accurate observation, perhaps be found to eat more insects than has heretofore been suspected. It will be observed that many of them are locust-egg-eaters. I will only refer to those of this family that I have actually found to destroy locusts or their eggs.

HESPERIPHONA VESPERTINA, (Coop.) Bp.

Evening Grosbeak.

Only occasionally seen in Nebraska at least; I have only met with it a few times in winter. In October, 1874, I shot one in Lancaster County. It had two locusts and a vast quantity of seeds in its stomach. I know nothing of its breeding-grounds.

PINICOLA ENUCLEATOR, (Linn.) Cab.

Pine Grosbeak.

This species occurs in Southeastern Nebraska in winter, but in small numbers. The following shows that it eats locust eggs in winter:

Number.	Locality.	Date.	Locust eggs in stomach.	Seeds in stomach.
1	Lancaster County, Nebraska	Dec. —, 1874	Large number	About half.
2	.....do	Jan. —, 1875	A very few	Large quantity.
3	.....do	...do	.....do	.....do.
4	.....do	Nov. —, 1876	Large number	About ½ seeds.
5	.....do	Feb. —, 1876	½ locust eggs	½ seeds.

These locust eggs must of course have been picked up where they had been laid bare by the winds.

CARPODACUS PURPUREUS, (Gm.) Gray.

Purple Finch.

For some reason have only seen this bird in Nebraska in October. In October, 1876, I shot three, but only one had a few locust eggs in its stomach.

LEUCOSTICTE TEPHROCOTIS, Sw.

Gray-crowned Finch.

This bird is frequently seen in Nebraska in winter, but rarely in summer. In fact, I saw it here but once at this season, which was in June, 1865, at which time I shot a specimen. Its stomach was crowded with seeds and three locusts. I also obtained one in February, 1875, but its stomach only contained seeds of weeds and grasses.

ÆGIOTHUS LINARIA, (Linn.) Cab.

Red-poll Linnet.

This bird appears irregularly in Nebraska. Often, where large flocks appeared one winter, I looked in vain for them the next. I have never seen them earlier than November. The following I have examined:

Number.	Locality.	Date.	Eggs in stomach.	Seeds in stomach.
1	Dakota City, Nebraska	Feb. 4, 1865	Very few	
2	do	Feb. 10, 1865	¼ filled with eggs	¾ seeds.
3	Lancaster County, Nebraska	Feb. —, 1875	¼ filled with eggs	Very many.
4	do	do	None	Seeds.

CHRYSOMITRIS TRISTIS, (Linn.) Bp.

American Goldfinch; Thistle-bird; Yellow-bird.

Common in Northern Nebraska. It occasionally, along with its proper food, eats locusts. Three specimens that I examined in June, 1865, had each a few locusts in its stomach. The first had 7, the second 4, and the third 13.

PLECTROPHANES NIVALIS, (Linn.) Meyer.

Snow-bunting; Snow-flake.

Common and abundant in Nebraska in winter. When it can get them, always eats locust eggs. The following I examined:

Number.	Locality.	Date.	Locust eggs in stomach.	Seeds in stomach.
1	Dakota County, Nebraska	Feb. —, 1865	¼ contents of stomach	Many seeds.
2	do	do	do	do.
3	Dixon County, Nebraska	do	A very few	do.
4	Lancaster County, Nebraska	Nov. —, 1874	⅛ contents of stomach	do.
5	do	Feb. —, 1875	⅛ contents of stomach	do.
6	do	Feb. —, 1877	do	do.

PLECTROPHANES LAPPONICUS, (Linn.) Selby.

Lapland Longspur.

Present in Nebraska, but not so abundant as the last. Of five specimens that I examined in November, 1874, only two had any locust eggs in the stomach, and only one had any considerable number.

PLECTROPHANES ORNATUS, Towns.

Chestnut-collared Bunting; Black-bellied Longspur.

Abundant in Nebraska, where it breeds. I have seen the young in June, July, and August, and it therefore must rear several broods in a season. This is one of the birds that might almost be classed as insectivorous. I have rarely killed one that I did not find some insects in its stomach. The following examples show its tendency to vary its seed diet with locusts:

Number.	Locality.	Date.	Locusts in stomach.	Seeds in stomach.
1	Dixon County, Nebraska	May 27, 1865	10	Indefinite.
2	Dakota County, Nebraska	May 30, 1865	15	.....do.
3	.....do	.....do	17	.....do.
4	.....do	June 10, 1865	12	.....do.
5	.....do	June 14, 1875	13	.....do.
6	.....do	.....do	16	.....do.

PLECTROPHANES MACCOWNI, Lawr.

Maccown's Bunting.

A few found in Nebraska. In August, 1874, I shot two on the Republican River, near Orleans. One of the two had 10 locusts and a beetle in its stomach.

POŒCETES GRAMINEUS, (Gm.) Bd.

Bay-winged Bunting; Grass Finch.

Abundant only in certain localities in Nebraska. It frequently varies its food with insect diet. The following examinations were made:

Number.	Locality.	Date.	Locusts in stomach.	Seeds in stomach.
1	Harlan County, Nebraska	Aug.—, 1874	16	Seeds.
2	..... do	..... do	18	.... do.
3	Lancaster County, Nebraska	Sept.—, 1874	14	.... do.
4	..... do	June 1, 1875	4	.... do.
5	..... do	June 13, 1875	15	.... do.

COTURNICULUS PASSERINUS, (Wils.) Bp.

Yellow-winged Sparrow.

Abundant in Nebraska, and breeds here. Of seven specimens that I examined in June, 1875, and June, 1877, four had from 10 to 20 locusts in their stomachs and the remainder only a few beetles and seeds.

COTURNICULUS HENSLOWI, (Aud.) Bp.

Henslow's Bunting.

I have only occasionally met with this bird in Nebraska, and the only specimen that I examined was one that was sent to me from Kearney Junction to identify, in September, 1874. It had 13 locusts in its stomach, besides a large quantity of seeds and a few beetles.

MELOSPIZA LINCOLNI, (Aud.) Bd.

Lincoln's Sparrow.

Great numbers pass through Nebraska in spring and fall, or during its migrations. I have seen the most in the latter part of September and October. The single one that I examined in September, 1874, shot in Lancaster County, had 11 locusts, 3 beetles, and a large number of seeds in its stomach.

MELOSPIZA MELODIA, (Wils.) Bd.

Song Sparrow.

Common in certain localities in Nebraska. Two that I examined in June, 1865, at Dakota City, had 13 and 17 locusts in their stomachs.

JUNCO HYEMALIS, (Linn.) Scl.

Eastern Snowbird.

A few are found here during the whole year, but the great mass pass northward in the spring. One killed in February, 1875, had a few locust eggs in its stomach and a large number of seeds. Another killed in the last of May, 1875, had 14 locusts, one beetle, and a large number of seeds in its stomach.

SPIZELLA MONTICOLA, (Gm.) Bd.

Canadian or Tree Sparrow.

Abundant in winter and a few breed here in summer. Shot one in June, 1877, near Lincoln, Nebr. It had 13 locusts, one larva, and a large number of seeds in its stomach.

SPIZELLA SOCIALIS, (Wils.) Bp.

Chipping Sparrow.

Very abundant in portions of Nebraska. Even in 1866, when there were no migrating locusts in Dakota County, the stomach of this sparrow was nearly always found to contain a few insects. In locust years, such as the fall of 1874 and 1876, and spring of 1875 and 1877, it made its meals largely on locusts. The largest number that I found in one of their stomachs was 17.

SPIZELLA PALLIDA, (Sw.) Bp.

Clay-colored Sparrow.

This bird is abundant in portions of Nebraska in May and October, during its migrations. Occasionally it breeds in Northern Nebraska. One specimen that I examined in June, 1865, had nine locusts in its stomach and also a large quantity of seeds, mostly of weeds and grasses.

ZONOTRICHIA ALBICOLLIS, (Gm.) Bp.

White-throated Sparrow.

This species is abundant in Nebraska in spring and autumn, during its migrations. Have seen no indications of its breeding in Nebraska. It is almost worthy of being classed with the insectivorous birds. I have never opened the stomach of one without finding a considerable number of insects.

Number.	Locality.	Date.	Insects found in stomach.
1	Dakota County, Nebraska	May 27, 1865	33, ½ locusts.
2	....do	....do	35, ¾ locusts.
3	Richardson County, Nebraska	Oct. 12, 1874	30, ½ locusts.
4	Lancaster County, Nebraska	May 20, 1875	40, ½ locusts.
5	....do	May 16, 1877	38, ½ locusts.

ZONOTRICHIA LEUCOPHRYS, (Forst.) Sw.

White-crowned Sparrow.

Only occasionally seen in Nebraska. In June, 1875, saw the young in Dixon County Nebraska, at the edge of a wood in the Missouri Bottom. But its breeding here must be rare. A solitary bird that was sent to me from Blair, Nebr., to identify, in the last of September, 1874, had, among other insects, 11 locusts in its stomach.

ZONOTRICHIA QUERULA, (Nutt.) Gamb.

Harris's Sparrow.

Common in Eastern Nebraska along the Missouri. Have not noticed it in winter, but have frequently seen the young in the northeastern part of the State.

A specimen sent to me for identification in the latter part of September, 1874, had 14 locusts, 5 beetles, and the larvæ of some other insects in its stomach, in addition to the seeds with which it satisfied its hunger. I regret that this was the only specimen that I have examined of this species.

CHONDESTES GRAMMICA, (Say) Bp.

Lark Finch.

Abundant in Nebraska, in the northeastern part of which it breeds. It also, in part at least, lives on insects, though its habits in this respect are exceedingly varied.

Number.	Locality.	Date.	Insects in stomach.	Seeds in stomach.
1	Dakota County, Nebraska	May 25, 1865	38, ½ locusts	Many seeds.
2	....do	June 1, 1865	14, ¾ locusts	....do.
3	....do	....do	20, ¾ locusts	....do.
4	Lancaster County, Nebraska	Sept.—, 1874	36, ¼ locusts	....do.
5	....do	....do	28, ¾ locusts	....do.
6	....do	Sept.—, 1876	22, ¾ locusts	....do.

CALAMOSPIZA BICOLOR, (Towns.) Bp.

Lark Bunting.

Rather abundant in Southern Nebraska, where it breeds. In June, 1875, out of nine specimens that I examined, seven had locusts in their stomachs, the lowest being 11 and the highest 19.

EUSPIZA AMERICANA, (Gm.) Bp.

Black-throated Bunting.

Common in Eastern Nebraska, and found to the west line of the State. The following examinations show the characters of this *seed-eating* bird:

Number.	Locality.	Date.	Insects in stomach.	Seeds in stomach.
1	Harlan County, Nebraska	Sept.—, 1874	33, ¾ locusts	Many seeds.
2	....do	....do	28, ¼ locusts	....do.
3	Richardson County, Nebraska	....do	36, ¾ locusts	....do.
4	....do	....do	24, ¾ locusts	....do.
5	Lancaster County, Nebraska	Sept.—, 1875	20, ¾ locusts	....do.

GONIAPHEA LUDOVICIANA, (Linn.) Bowd.

Rose-breasted Grosbeak.

Rather abundant in Northern Nebraska. Examined two specimens in June, 1865 Each had about a dozen of locusts in its stomach.

GONIAPHEA MELANOCEPHALA, (Sw.) Gray.

Black-headed Grosbeak.

I have seen this bird myself only along the Republican River in Southwestern Nebraska. Two specimens were sent to me from Kearney Junction in June, 1875, to identify. One contained 8 and the other 17 locusts, besides a large number of seeds.

GONIAPHEA CŒRULEA, (Linn.) Gray.

Blue Grosbeak.

Only occasionally met with in Nebraska. One that was sent to me from Grand Island in September, 1873, had three grasshoppers, a dozen other insects, and many seeds in its stomach. As there were no migratory locusts there at the time, these grasshoppers must have belonged to some other species, which in their condition I could not identify

CYANOSPIZA CYANEA, (Linn.) Bd.

Indigo-bird.

Rare in Nebraska. A specimen sent to me to identify from Beatrice, Nebr., in the extreme southern part of the State, had 10 locusts in its stomach and a large number of seeds. This was in June, 1875. Another, obtained a little later from Columbus on the Platte, had only one locust in its stomach, but 8 small beetles. Seeds numerous.

CARDINALIS VIRGINIANUS, (Briss.) Bp.

Cardinal Grosbeak; Virginian Redbird.

Abundant in Southern Nebraska, where it breeds. It also varies its diet with locusts when it can obtain them.

Number	Locality.	Date.	Insects in the stomach.
1	Harlan County, Nebraska	Aug. —, 1874	22, $\frac{1}{2}$ locusts.
2	Richardson County, Nebraska	Sept. —, 1874	24, $\frac{3}{4}$ locusts.
3	....do	....do	20, $\frac{1}{2}$ locusts.
4	....do	....do	22, $\frac{1}{2}$ locusts.

PIPILO ERYTHROPHTHALMUS, (Linn.) Vieill.

Ground Robin; Marsh Robin; Towhee Bunting; Chewink.

Large numbers pass through Northern Nebraska on their migrations. A few stop to breed. In May and June, 1865, I examined four of these birds. Three of the four had locusts in their stomachs, averaging 11, besides a few beetles and a large number of seeds.

Family ICTERIDÆ: AMERICAN STARLINGS.

DOLICHONYX ORYZIVORUS, (Linn.) Sw.

Bobolink; Reed-bird; Rice-bird.

Very abundant in Nebraska, where it breeds. It is reputed to be wholly granivorous, especially when it frequents the swamps of the South and becomes the rice-bird. That it is sometimes slightly insectivorous, I have seen in a great many of my examinations of this bird. The following are examples:

Number.	Time.	Date.	Insects in the stomach.	Seeds in stomach.
1	Dakota County, Nebraska	May 30, 1866	21	Many seeds.
2	....do	June 5, 1866	18	....do.
3	....do	June 15, 1866	16	....do.
4	Lancaster County, Nebraska	May 30, 1875	12 locusts	....do.
5	....do	June 12, 1875	14 locusts	....do.
6	....do	....do	17 locusts	....do.

MOLOTHRUS ATER, (Bodd.) Gray.

Cow-bird; Cow-blackbird.

This bird is unfortunately abundant in Nebraska, and every one who hunts birds' nests in June will find its eggs dropped into some other nest. In addition to being parasitic, it is polygamous. Its only good trait is that it is highly insectiverous. During locust years, it is found to feed largely on this insect as well as the flies and larvæ of flies that pester castle. Hon. J. Sterling Morton says that it eats grubs out of the backs of lean cattle in spring.

AGELÆUS PHŒNICEUS, (Linn.) Vieill.

Red-winged Blackbird

Common along water-courses in Nebraska. This supposed granivorous bird varies his diet quite extensively with insect food. In the spring of 1875, on the road from

Lincoln, Nebr., to Milford, where the road crosses Oak Creek, I observed some Red-wings flying backward and forward to the neighboring bluffs, especially to one point near and on some old breaking. Going to this spot, I found it well covered with young locusts, and many of the birds feeding on them. To make sure of this, I shot one, and found its stomach half full of young locusts; more, in fact, of these insects than of seeds. On two other occasions I made a similar observation.

XANTHOCEPHALUS ICTEROCEPHALUS, (Bp.) Bd.

Yellow-headed Blackbird.

Very abundant in Nebraska, where it breeds. This bird is often charged here with picking up the farmers' seed, but I doubt whether it ever does much harm in this direction. The following I have examined:

Number.	Locality.	Date.	Insects in stomach.	Other substances.	Grains of seeds.
1	Dakota County, Nebraska	May 10, 1865	37	Locust eggs	10
2	do	do	36		30
3	do	May 20, 1865	51 locusts		10
4	do	do	45 do		21
5	do	June —, 1865	49 do		20
6	do	May —, 1866	35 beetles	Insect eggs.	24
7	do	June —, 1867	42 do		17
8	do	do	47 insects		21
9	do	do	40 do		37
10	do	May —, 1868	33 do		19
11	do	June —, 1868	42 do		40
12	do	do	45 do		30
13	do	May —, 1869	42 do		18
14	Lancaster County, Nebraska	May —, 1872	59 do		15
15	do	June —, 1872	38		19
16	do	May 8, 1875	48	Locust eggs	18
17	do	June —, 1875	47		16
18	do	do	45		
19	do	June —, 1877	43		4
20	do	do	58		3

STURNELLA MAGNA, (Linn.) Bd.

Meadow-lark; Field-lark.

This bird is exceedingly abundant in Nebraska, being found almost everywhere on the prairies; var. *magna* and var. *neglecta* both here, but the latter most abundant. Here apparently as insectivorous as granivorous. The following is my record of examinations:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Grains and eggs.
1	Dakota County, Nebraska	May 10, 1865		10	Locust eggs.
2	do	May 20, 1865	27	3	Grains.
3	do	June 15, 1865	37	1	33 grains.
4	do	June —, 1866	1?	22	42 grains.
5	Lancaster County, Nebraska	May 27, 1875	19	3	Not counted.
6	do	do	26	5	do.
7	do	June 27, 1875	35		do.
8	do	do	33		do.
9	do	do	36		do.

ICTERUS SPURIUS, (Linn.) Bp.

Orchard Oriole; Chestnut Hangnest.

Common but not abundant in Nebraska, and breeds here. These birds are well known to be largely insectivorous. One that I killed in June, 1865, near Dakota City, had its stomach three-fourths filled with locusts. Another examined near Lincoln, Nebr., in June, 1875, had about the same amount of locusts in its stomach.

ICTERUS BALTIMORE, (Linn.) Daud.

Baltimore Oriole; Golden Robin; Hangnest.

Common all over Eastern Nebraska where there is woodland or orchard. I have never opened the stomach of one of these birds. In fact, I have never been able to bring myself to shoot one even for scientific purposes. But in the spring of 1865 I watched two old birds feeding their young near Dakota City, and again in Lincoln in 1873. In the first case, the old birds brought their young a great many locusts. They flew from the low cottonwood, where their hangnest was fastened, to a neighboring field every few minutes. In this field, locusts were abundant, and these they picked up and carried to their nests, and every time seemed to swallow some themselves. I ascertained this by watching them by the hour.

ICTERUS BULLOCKI, (Sw.) Bp.

Bullock's Oriole.

This bird is also frequently seen in Nebraska. I found one eating locusts in August, 1874, on the Republican River, in Southwestern Nebraska. One that I opened in Dixon County, Nebraska, in June, 1865, had 35 locusts, 3 beetles, and some seeds in its stomach. It seems to be most abundant in the wooded portions toward the western end of the State.

SCOLECOPHAGUS FERRUGINEUS, (Gm.) Sw.

Rusty Grackle.

This species abounds in early spring and in the last of September and October during its migrations. Have seen no sign of its breeding in Nebraska. It is a great insect-eater. In October, 1874, I opened a number of these birds in Lancaster County, and a few in Richardson County. The stomachs in each instance were crowded with insects, four-fifths of which were locusts, and a few seeds.

SCOLECOPHAGUS CYANOCEPHALUS, (Wagl.) Cab.

Blue-headed Grackle; Brewer's Blackbird.

Once very abundant in Nebraska, where it breeds; is again on the increase. During my early years in Nebraska, countless numbers of these birds, along with the crow blackbird, were destroyed by the early settlers. The blackbirds visited the corn-fields in September, and stripped the ends of the ears to get at a grub that infested the corn. If abundant rains followed, a portion of the exposed corn was damaged. The impression became general that the blackbirds were destroying the corn. The farmers soaked corn in strychnine and sowed it around their corn-fields for the birds to eat. I have seen dead blackbirds and other birds that were destroyed in this way piled up in heaps three and four feet high. And yet the birds were comparatively innocent. In September, 1866, I examined a pile of birds in a field a few miles west of Dakota City. Out of forty of these blackbirds there were only five that had over a dozen grains of corn in their stomachs. They were filled with insects and their larvæ. In September, 1874, in Lancaster County, all of a dozen of these birds that I opened had their stomachs three-fourths full of locusts, and other insects were about as abundant as the seeds that accompanied them.

QUISCALUS PURPUREUS, (Bart.) Licht.

Purple Grackle; Crow Blackbird.

Rather abundant in Eastern Nebraska, though hardly as much so as the preceding. It is highly insectivorous. During this last spring a field of wheat north of Lincoln was literally covered with locusts. I one day observed a large flock of these birds light down on this field, and after once getting a taste they returned day after day for more than a week. At the end of that time hardly a locust could be found. On the third day of their visits I shot one and found its stomach filled with locusts. I never failed to find locusts in the stomach of this bird whenever locusts were about. At other times other insects made up a large portion of its food, and yet the bird cannot be recommended. I have more than once witnessed its well-known habit of robbing other birds of their eggs, which it sucks, and sometimes of its young. It does not therefore compare in value with the preceding bird for the agriculturist. Once I found the remains of small fish in its stomach, but how it obtained them I do not know.

Family CORVIDÆ: CROWS, ETC.

CORVUS CORAX, Linn.

Raven.

Formerly frequently seen in Nebraska, especially in its northern part; latterly seldom met with. The single one that I examined in June, 1865, had insects, meat, and seeds in its stomach. Among the insects were a dozen of locusts.

CORVUS CRYPTOLEUCUS, Couch.

White-necked Raven.

Only saw this bird once in Nebraska. It was on the Republican River, near the west line of the State, in April, 1877. I place it among locust-eating birds only because of the known habits of its congeners.

CORVUS AMERICANUS, Aud.

Common Crow.

In 1865, 1866, and 1867 vast numbers were poisoned in Northern Nebraska, where it was then exceedingly abundant. All those that I opened that had been poisoned in the spring of 1865 had their stomachs partly filled with locusts. In the two last years insects of other species constituted the contents of their stomachs. I do not wish to defend the crow, because he is known to destroy the eggs and young of other birds; but there is no question but that with the harm that he does he also destroys a vast number of insects. His great fault is that he eats everything that he can get—what is of value as well as what is harmful to the farmer.

PICICORVUS COLUMBIANUS, (Wils.) Bp.

Clarke's Crow; American Nutcracker.

Only found in the western part of the State. One that was sent to me from Sidney, Nebr., in October, 1874, to identify, had 41 locusts in its stomach; also some seeds of the pine, a grain of corn, and a dozen of other grains. It is evidently omnivorous,

PICA MELANOLEUCA HUDSONICA, (Sab.) Coues.

American Magpie.

Occasional in Northern and more common in Western Nebraska. I have never succeeded in capturing one during locust years; but as it is omnivorous it no doubt indulges in locusts when they can be obtained. The single one that I opened in July, 1867, in Dixon County, Nebraska, had its stomach half full of insects, among which was one *C. femur-rubrum*. Owing to its propensity to destroy the eggs and young of other birds, its increase is not desirable.

CYANURUS CRISTATUS, (Linn.) Sw.

Blue Jay.

Comparatively few in Nebraska; breeds here. In September, 1874, examined two jays in Richardson County, Nebraska. Three-fourths of the contents of the stomachs were locusts. One that was sent to me in September, 1876, from Nebraska City, had 45 locusts and some seeds in its stomach. It is evident from their known character as omnivorous birds that when they can be obtained they will destroy great numbers of locusts. They, too, have the bad reputation of destroying the eggs and young of other birds, but to what extent I have not ascertained. It is doubtful, however, whether they are a desirable bird for increase. Since writing the preceding, Hon. J. Sterling Morton tells me that they are abundant in Otoe County, and do much harm to other birds.

Suborder CLAMATORES.

Family TYRANNIDÆ: AMERICAN FLYCATCHERS.

TYRANNUS CAROLINENSIS, Temm.

Kingbird; Bee-martin.

Abundant as far west as the middle of Nebraska, and occurs sparingly to the west line of the State. These birds being highly, if not wholly, insectivorous, would naturally be expected to eat locusts. No insect comes amiss to them. The following I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Grains.
1	Dakota County, Nebraska	June —, 1866		57	
2	do	July —, 1866		54	3
3	do	July —, 1867		61	
4	do	Sept. —, 1869		59	
5	Lancaster County, Nebraska	Sept. —, 1874	48	13	
6	do	do	53	8	1
7	do	May —, 1875	60	1	
8	do	Sept. —, 1876	55	2	

TYRANNUS VERTICALIS, Say.

Arkansas Flycatcher.

This bird abounds along the wooded streams in Southwestern Nebraska. I observed great numbers of them along the Republican River in August, 1874. And though I dissected none of them I saw them capture locusts, which were becoming abundant, on the wing, and judging from the habits of its near relative, the preceding bird, it must destroy great numbers.

MYIARCHUS CRINITUS, (Linn.) Cab.

Great Crested Flycatcher.

Only found in this State in its southeastern portions. Most abundant in Richardson and Nemaha Counties. In September, 1873, one was sent to me for identification from Brownville. There were 58 insects in its stomach, and of these 23 were various species of grasshoppers. From the known habits of its congeners it must also prey on the locusts.

SAYORNIS SAYUS, (Bp.) Bd.

Say's Flycatcher.

Have only observed it in Central and Western Nebraska. At Kearney Station have seen the most. One sent from this place to identify had 32 locusts in its stomach. This was in the fall of 1876. At other times when I examined them their stomachs were crowded with various insects.

SAYORNIS FUSCUS, (Gm.) Bd.

Pewit Flycatcher; Phabe-bird.

Have only observed this bird in Eastern Nebraska along the Missouri. The following is my record of dissections:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Grains.
1	Dakota City, Nebraska	June —, 1866	.....	47	3
2	.....do	June —, 1868	.....	43	1
3	... do	July —, 1870	.....	28	.....
4	Lancaster County, Nebraska	Sept. —, 1874	39	2	.....
5	.....do	.....do	35	7	.....
6	.....do	May 20, 1875	30	16	2
7	.....do	June —, 1875	43	0	.....
8	Richardson County, Nebraska	Sept. —, 1876	34	12	.....
9	Lancaster County, Nebraska	June —, 1877	32	9	.....

CONTOPUS BOREALIS, (Sw.) Bd.

Olive-sided Flycatcher.

This bird is reputed to be abundant in the West, but I have only occasionally met it in Nebraska. I have dissected none in locust years. One, however, that I examined in July, 1869, had 17 grasshoppers among the insects in its stomach. There can be no doubt of its feeding on locusts when they are present.

CONTOPUS VIRENS, (Linn.) Cab.

Wood Pewee.

A very few of these birds in the timber belts of Eastern Nebraska along the Missouri. One that I dissected in June, 1869, at Dakota City, had seven grasshoppers in its stomach besides a great many other insects. I obtained none for examination during locust years.

CONTOPUS RICHARDSONI, (Sw.) Bd.

Western Wood Pewee.

Frequently seen wherever there is woodland or timber-skirted streams in Western Nebraska. Have not observed it as far east as the Missouri. In June, 1875, two were sent to me from the Wood River to identify. Three-fourths of the contents of their stomachs were composed of locusts. One that I obtained at Sidney, Nebr., had 22 locusts in its stomach.

EMPIDONAX TRAILLI, (Aud.) Bd.

Traill's Flycatcher.

I have not distinguished between the two species of this bird—var. *traillii* and var. *pusillus*—but my impression is that the latter is the most abundant of the two, though I have only occasionally met either one. I have made no dissections and only assign them to the list of locust-eating birds from the known characters of their congeners.

EMPIDONAX MINIMUS, Bd.

Least Flycatcher.

Rather common in Nebraska, and occasionally breeds in the northeastern portion of the State. I only examined a few specimens in 1865 and 1866.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota City, Nebraska	May 30, 1865	19	Not counted.
2	do	June —, 1865	22	do.
3	do	July —, 1866		27
4	do	July —, 1866		31

EMPIDONAX FLAVIVENTRIS, Bd.

Yellow-bellied Flycatcher.

This bird occurs sparingly in Eastern Nebraska, and have known it to breed on the skirts of timber belts along the Missouri. The only one that I dissected was obtained in July, 1870, near Dakota City. It had 16 grasshoppers among the insects in its stomach.

Order PICARIÆ: PICARIAN BIRDS.

Suborder CYPSELI: CYPSELIFORM BIRDS.

Family CAPRIMULGIDÆ: GOATSUCKERS.

ANTROSTOMUS VOCIFERUS, (Wils.) Bp.

Whippoorwill.

Occasionally found in Eastern Nebraska, where it breeds. In August, 1867, when encamped on the Bow River, in Northeastern Nebraska, during a locust invasion, I shot two of these birds. Each had its stomach crowded with locusts. I have dissected no others.

ANTROSTOMUS NUTTALLI, (Aud.) Cass.

Nuttall's Whippoorwill.

Rather common in Central and Western Nebraska, in the vicinity of timber. Occasionally seen further east. In August, 1869, when camped on the Bow River, in Northern Nebraska, on a moonlight night, I was kept awake by one of these birds. Having long desired to secure one, I crept out toward the place from which the sound of "poor will" issued. On the wing I shot the bird, and the next morning I found that four-fifths of the contents of the stomach were composed of grasshoppers and locusts

CHORDEILES VIRGINIANUS, (Gm.) Bp.

Night-hawk; Bull-bat; Pisk.

Common in Nebraska, and breeds here. The following I have dissected:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Cedar County, Nebraska	Aug. —, 1867	49	15
2	do	do	55	6
3	do	Sept. —, 1867	52	12
4	Harlan County, Nebraska	Aug. —, 1874	44	18
5	Lancaster County, Nebraska	Sept. —, 1874	50	8
6	Sarpy County, Nebraska	June —, 1875	58	9
7	Otoe County, Nebraska	do	49	Not ascertained.

Family CYPSELIDÆ: SWIFTS.

CHÆTURA PELAGICA, (Linn.) Bd.

Chimney Swift; Chimney Swallow.

Abundant in Eastern Nebraska. I have never dissected old birds; but generally when I found young ones at the bottoms of chimneys, to which they had fallen, I examined the contents of their stomachs. Those that I examined in May and June, 1865, and in the same months in 1875, in Lincoln, Nebr., invariably had more or less locusts in their stomachs. At other times they had various kinds of insects.

Family TROCHILIDÆ: HUMMINGBIRDS.

TROCHILUS COLUBRIS, Linn.

Ruby-throated Hummingbird.

In June, 1875, I took one of these birds from a cat that had caught it in Lincoln, Nebr. It had four small locusts in its stomach. This is the only observation that I made on the feeding habits of this species.

Family ALCEDINIDÆ: KINGFISHERS.

CERYLE ALCYON, (Linn.) Boie.

Belted Kingfisher.

Frequently seen in Nebraska. One that was sent to me to identify in September, 1874, had 18 locusts, in addition to portions of some fish, in its stomach. One that I opened in September, 1876, had mingled at least 14 locusts with his fish diet. These are the only examinations that I made on this bird.

Family CUCULIDÆ: CUCKOOS.

COCCYGUS ERYTHROPHTHALMUS, (Wils.) Bp.

Black-billed Cuckoo.

A single specimen of this bird, which I bought in a butcher-shop in Lincoln, Nebr., in the last days of September, 1876, had 41 locusts in its stomach. It is only occasionally met in this State.

COCCYGUS AMERICANUS, (Linn.) Bp.

Yellow-billed Cuckoo.

More frequently seen in Nebraska than the last. Breeds here. The following I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Cedar County, Nebraska	Aug. —, 1867	47	10
2	do	do	49	6
3	Dixon County, Nebraska	Sept. —, 1867	28	24
4	do	do	37	15
5	Otoe County, Nebraska	Sept. —, 1874	50	6
6	Cass County, Nebraska	do	43	16
7	Lancaster County, Nebraska	June —, 1875	38	20
8	Richardson County, Nebraska	Sept. —, 1876	46	12
9	Sarpy County, Nebraska	June —, 1877	40	23
10	do	do	38	20

Family PICIDÆ: WOODPECKERS.

PICUS VILLOSUS, Linn.

Hairy Woodpecker.

Abundant in the woody portions of the Missouri bottoms and other rivers in Nebraska. For food it takes apparently any insect that comes in its way. The following examinations of specimens seem to prove this:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	July —, 1866	.....	*59
2	do	do	.....	55
3	Cedar County, Nebraska	Aug. —, 1867	49	8
4	do	do	32	24
5	Otoe County, Nebraska	Sept. —, 1874	35	25
6	Cass County, Nebraska	Sept. —, 1876	41	22

* One a hornet.

PICUS PUBESCENS, Linn.

Downy Woodpecker.

Much less abundant than the preceding, but still frequently seen among the timber of the river-bottoms. The following examples of dissections show their feeding habits:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dixon County, Nebraska	Sept. —, 1867	43	20
2	do	do	38	29
3	do	June —, 1868	39	25
4	Cass County, Nebraska	Sept. —, 1874	45	16

SPHYRAPICUS VARIUS, (Linn.) Bd.

Yellow-bellied Woodpecker.

Rather common in the bottoms of the Missouri and other streams in Eastern Nebraska. It eats different kinds of insects and grains, unless the following specimens that I examined were exceptional:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Seeds.
1	Dakota County, Nebraska	June —, 1865	27	15	17
2	Dixon County, Nebraska	June —, 1868	33	11	14
3	....do	....do	26	22	29
4	Cass County, Nebraska	Oct. —, 1874	15	22	20
5	Lancaster County, Nebraska	June —, 1875	29	17	8

CENTURUS CAROLINUS, (Linn.) Sw.

Red-bellied Woodpecker.

Rather common in spots in Southern Nebraska. Have rarely seen them north of the Platte. Two that I obtained from a sportsman in September, 1874, in Lancaster County, had each the stomach half full of locusts. The other half was mostly different species of insects and their larvæ.

MELANERPES ERYTHROCEPHALUS, (Linn.) Sw.

Red-headed Woodpecker.

Common in Nebraska, wherever there is timber enough to satisfy their natures. Breeds here. Sometimes varies its food with locusts, as the following cases prove:

Number.	Locality	Date.	Locusts in stomach.	Other insects.	Grains.
1	Dakota County, Nebraska	June —, 1865	32	29	10
2	....do	Aug. —, 1866	.....	62	3
3	Dixon County, Nebraska	June —, 1868	39	15	10
4	....do	June —, 1869	.....	65	3
5	Cass County, Nebraska	Sept. —, 1874	41	20	5
6	....do	....do	37	19	15

COLAPTES AURATUS, (Linn.) Sw.

Golden-winged Woodpecker; Flicker.

Abundant in the wooded portions of Nebraska. Sometimes seen a considerable distance from any timber. Breeds here. On or about June 1, 1865, I bought eight flickers from a sportsman, who had shot them in a wood in Dixon County, Nebr. The following is an account of the contents of their stomachs:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Grains, etc.
1	Dixon County, Nebraska	June —, 1865	15	40	8
2	....do	....do	28	31	2
3	....do	....do	40	14	0
4	....do	....do	20	29	3
5	....do	....do	16	45	6
6	....do	....do	47	7	8
7	....do	....do	38	21	4
8	....do	....do	48	12	0

COLAPTES MEXICANUS, Sw.

Red-shafted Woodpecker; Mexican Flicker.

This woodpecker is occasionally seen in Nebraska, but is not abundant. In August of this year I saw a few on the Niobrara River, and also in Richardson County, in the southeastern part of the State. A single one that was sent to me to identify in June of this year from near Nebraska City had 18 locusts and 31 other insects in its stomach. I failed to get any others.

Order RAPTORES: BIRDS OF PREY.

Family STRIGIDÆ: OWLS.

STRIX FLAMMEA AMERICANA, (Aud.) Schl.

American Barn Owl.

Only occasionally found in Nebraska, but breeds here. It is probably an innocent bird; at least, the only three specimens that I obtained for dissection had only insects and mice in them, as follows:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other matter.
1	Dixon County, Nebraska	Aug. —, 1867	39	22	Part of a mouse.
2	Dakota County, Nebraska	July —, 1868	.....	55	
3	Lancaster County, Nebraska	June —, 1872	.....	40	Part of a mouse.

BUBO VIRGINIANUS, (Gm.) Bp.

Great Horned Owl.

A single specimen of this bird that I dissected contained the remains of a gopher and about 30 insects. This was in Dakota County, in July, 1869.

SCOPS ASIO, (Linn.) Bp.

Red Owl; Mottled Owl; Screech Owl.

Often met with in the wooded portions of Nebraska, where it breeds. It is largely an insect-eating bird, as the following dissections show:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other matter.
1	Cedar County, Nebraska	Sept. —, 1867	47	12	
2	do	do	32	8	Small bird.
3	do	June —, 1868	41	22	
4	Dakota County, Nebraska	July —, 1869	.....	69	Mouse.
5	do	Aug. —, 1870	.....	38	Mouse.
6	Seward County, Nebraska	Sept. —, 1872	.....	67	
7	Nemaha County, Nebraska	Sept. —, 1874	50	16	
8	Lancaster County, Nebraska	June —, 1875	49	15	

OTUS VULGARIS WILSONIANUS, (Less.) Allen.

American Long-eared Owl.

I obtained but one specimen of this owl during thirteen years' residence in Nebraska, and here it must be rare. This one, captured in July, 1865, in Dakota County, had a few insects and part of a rabbit in its stomach.

BRACHYOTUS PALUSTRIS, (Bechst.) Gould.

Short-eared Owl.

This owl is frequently seen on the borders of the Missouri bottoms in Nebraska. I found one nest in a burrow on the side of a bluff in Dixon County. One that I ob-

tained here from a sportsman in September, 1868, had 30 locusts and a part of a gopher in its stomach. Another brought to me in Dakota County in July, 1870, had 17 insects and part of a rabbit in process of digestion.

SYRNIUM NEBULOSUM, (Forst.) Boie.

Barred Owl.

Very seldom seen in Nebraska. I was so fortunate as to see one in Cedar County, Nebraska, nearly opposite Yankton, in 1867, when the locusts were flying. It was capturing some of them on the wing, which I could distinctly see with my field-glass. I never obtained one for dissection.

NYCTEA SCANDIACA, (Linn.) Newt.

Great White or Snowy Owl.

Frequently seen in winter and occasionally in late autumn in Nebraska. I regret to be compelled to say that three out of the four that I dissected in the winter of 1865 and the autumn and winter of 1867 and 1870 had only the remains of quail and grouse in their stomachs. The fourth, obtained in October, 1867, had 10 insects and a rabbit as a portion of its last meal on earth.

SPHEOTYTO CUNICULARIA HYPOGÆA, (Bp.) Coues.

Burrowing Owl.

Abundant in Central and Western Nebraska, and sparingly present almost to the Missouri. Formerly more numerous than at present, but for some reason it retires westward. Twelve years ago they were quite abundant in the Logan and Elkhorn Valleys, but now only occasionally seen. This bird is highly insectivorous, as the following dissections show. Sometimes found away from prairie-dog towns:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Wayne County, Nebraska	June —, 1868	.....	62	
2	.....do	.....do	.....	30	Lizard.
3	Pierce County, Nebraska	.....do	49	17	
4	.....do	.....do	46	10	Young prairie dog.
5	.....do	.....do	54	8	
6	Wayne County, Nebraska	July —, 1869	.....	65	Mouse.
7	Sidney, Cheyenne County, Nebraska	June —, 1875	59	3	
8	Ogalalla, Keith County, Nebraska	Sept. —, 1876	51	12	Mouse.
9	.....do	.....do	58	4	

Family FALCONIDÆ: DIURNAL BIRDS OF PREY.

CIRCUS CYANEUS HUDSONIUS, (Linn.) Schl.

Marsh Hawk; Harrier.

Occasionally seen in Nebraska; most abundant in the northeastern portion of the State and along the Missouri. Coues says that in addition to insects they eat reptiles and small quadrupeds, but I found only one of the latter in the following specimens that I examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Bazile Creek, Nebraska	Oct. —, 1869	.....	69	Reptiles.
2	.....do	.....do	15	77	
3	Otoe County, Nebraska	Sept. —, 1864	71	10	
4	Sarpy County, Nebraska	.....do	69	.....	Lizard.
5	.....do	.....do	51	.....	Young gopher.
6	Douglas County, Nebraska	Oct. —, 1864	43	.....	Lizards.

ELANOIDES FORFICATUS, (Linn.) Coues.

Swallow-tailed Kite.

I have seen this kite as far north as Cedar County and as far west as the meridian of Fort Kearney. In Dixon County a pair nested for at least four years in succession on a cottonwood on Badger Creek. Insects are probably its principal food; at least, I never found anything else in its stomach.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dixon County, Nebraska	June —,1865	60	5
2	do	do	69	3
3	Sarpy County, Nebraska	Sept. —,1873		75

ACCIPITER FUSCUS, (Gm.) Gray.

Pigeon Hawk.

Unfortunately too abundant in Nebraska; and the half dozen specimens that I examined at different times all contained, in addition to some insects, the remains of birds.

ACCIPITER COOPERI, (Bp.) Gray.

Cooper's Hawk; Chicken Hawk.

Like the preceding, whenever I have examined it, its stomach contained a few insects, but a large amount of birds. Sometimes, but I think not often, it captures a young rabbit or a gopher. Of six that I dissected, only one contained the remains of a small mammal.

ASTUR ATRICAPILLUS, (Wils.) Jard.

The American Goshawk.

Present but rare on the prairies of Nebraska. Unfortunately, while it devours some insects, it destroys more birds. The single one that I dissected in August, 1867, on the borders of Dixon and Cedar Counties, had a few locusts and the remains of a rabbit and quail in its stomach.

FALCO MEXICANUS POLYAGRUS, (Cass.) Coues.

American Lanier or Prairie Falcon.

Only occasionally seen in Nebraska. One that was sent to me from Sarpy County in September, 1874, had 16 locusts and part of a prairie chicken in its stomach. Evidently not a desirable bird for the State.

FALCO COMMUNIS, Gm.

Peregrine Falcon; Duck Hawk.

Have seen this hawk but three times in the State, and obtained none for examination. I place it here only because of the known characters of its congeners.

FALCO COLUMBARIUS RICHARDSONI, Ridgw.

American Merlin.

Rather common in Nebraska. Breeds here. Two that I dissected in August, 1869, at Dakota City, Nebr., had each about a dozen insects and the remains of birds in their stomachs.

FALCO SPARVERIUS, Linn.

Sparrow Hawk.

Very abundant in Nebraska, and breeds here. It is questionable whether this hawk should be preserved or destroyed, as the following dissections make this uncertain:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dixon County, Nebraska	July —, 1865	8	27	Mouse.
2	Dakota County, Nebraska	..... do	.....	38	Gopher.
3	..... do	June—, 1866	.....	29	Quail.
4	..... do	July —, 1866	.....	34	Gopher.
5	..... do	Aug.—, 1867	.....	22	Rabbit.
6	Cedar County, Nebraska	..... do	47	.....	Mice.
7	Pierce County, Nebraska	July —, 1869	.....	41	Gopher.
8	Sarpy County, Nebraska	Sept.—, 1871	.....	37	Mice.
9	..... do	June—, 1872	.....	43	Bird.
10	Lancaster County, Nebraska	Sept.—, 1873	.....	40	Frogs.

BUTEO BOREALIS, (Gm.) Vieill.

Red-tailed Buzzard; Hen Hawk.

Common in Nebraska. The single one that I examined in July, 1870, at Dakota City, had 37 insects and a quail in its stomach.

BUTEO SWAINSONI, Bp.

Swainson's Buzzard.

Rather abundant in the State in the vicinity of streams of water where timber exists. I doubt whether they often capture birds. The following examinations of specimens indicate this:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Cedar County, Nebraska	Aug.—, 1867	68	.....	Gopher.
2	..... do	..... do ...	61	.....	Gopher.
3	Dakota County, Nebraska	July —, 1868	.....	58	Rabbit.
4	Sarpy County, Nebraska	Sept. —, 1872	.....	65	Gopher and mouse.

ARCHIBUTEO LAGOPUS SANCTI-JOHANNIS, (Gm.) Ridgw.

American Rough-legged Hawk.

Rare in Southern Nebraska. The only specimen that I examined was sent to me from Beatrice in September, 1873. It had in its stomach 70 insects, parts of a lizard, and a gopher.

ARCHIBUTEO FERRUGINEUS, (Licht.) Gray.

Ferrugineous Buzzard, or California Squirrel Hawk.

I have seen but one of these hawks in Nebraska. This was near Ogalalla, in the Platte Valley, in June, 1874. I failed to secure it. I place it in the list of locust-eating birds because of the known characters of its congeners.

The golden and the bald eagle are both occasionally seen in Nebraska, especially the latter. The former I have twice seen on the Republican, and the latter frequently along the Missouri. Some herdsmen that I met near the Forks of the Republican claimed that they had seen the golden eagle catching locusts while they were flying, in September, 1876. I know nothing of this, and give this report for what it may be worth.

Order COLUMBÆ: Pigeons, etc.

Family COLUMBIDÆ: Pigeons.

Ectopistes macrura, (Linn.) Coues.

Wild Pigeon; Passenger Pigeon.

In some years abundant in Nebraska, and in other years rarely to be seen. Though supposed to live wholly on grains, it will occasionally eat insects. In September, 1874, I bought six at a butcher-shop in Lincoln, which were said to have been brought there by a sportsman. The following was the result of an examination of their stomachs:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Lancaster County, Nebraska	Sept. —, 1874	11		61 grains.
2	do	do	8		
3	do	do		15	70 grains.
4	do	do	15	1	Not counted.
5	do	do	7		do.
6	do	do	10		do.

Zenædura carolinensis, (Linn.) Bp.

Carolina Dove; Common Dove.

Abundant in Nebraska. I have only examined a few specimens that I obtained from sportsmen, with the following result:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dixon County Nebraska	July —, 1865	2	3	50 grains.
2	Dakota County, Nebraska	June —, 1866		5	58 grains.
3	Wayne County, Nebraska	July —, 1868		9	53 grains.
4	Sarpy County, Nebraska	Sept. —, 1872			69 grains.
5	Lancaster County, Nebraska	Sept. —, 1873		4	57 grains.
6	do	Sept. —, 1874	7		59 grains.

Order GALLINÆ: Gallinaceous Birds.

Family MELEAGRIDIDÆ: Turkeys.

Meleagris gallopavo americana, (Bartr.) Coues.

Common Wild Turkey.

Formerly very abundant in Nebraska, but now rapidly being reduced in numbers and disappearing from localities where a few years ago there were still great numbers. It destroys great numbers of insects, and in locust years makes them its principal food. The following specimens I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Seeds and grains.
1	Dixon County, Nebraska	Aug. —, 1865	13	49	30
2	do	Aug. —, 1867	58		27
3	do	Sept. —, 1867	60	3	19
4	do	do	51		37
5	do	do	69	5	10
6	Dakota County, Nebraska	Sept. —, 1868	8	51	18

Family TETRAONIDÆ: THE GROUSE, ETC.

Subfamily TETRAONINÆ: GROUSE.

CENTROCERCUS UROPHASIANUS, (Bp.) Sw.

Sage Cock; Cock of the Plains.

Have only seen it once alive, and that in Western Nebraska; several, however, have been sent to me from the following localities:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	North Platte	Oct. —, 1874	44	.....	Sage leaves.
2	Sidney, Nebraska	.....do.....	57	.....	Sage leaves.
3	.....do.....	.....do.....	40	7	Sage leaves.
4	Pine Bluff, Nebraska	Sept. —, 1876	49	4	Sage leaves.

PEDIŒCETES PHASIANELLUS COLUMBIANUS, (Ord.) Coues.

Southern Sharp-tailed Grouse.

Formerly very abundant in Nebraska, but gradually decreasing in numbers. It is a mistake to suppose, as some do, that this grouse feeds exclusively on seeds, buds, and leaves. The following examinations of specimens prove that at least occasionally they live partially on insects:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	Feb. —, 1865	.....	.....	Buds and seeds.
2	.....do.....	May —, 1865	29	.....	Seeds.
3	.....do.....	July —, 1865	10	22	Seeds.
4	.....do.....	Aug. —, 1866	.....	27	Seeds.
5	Cedar County, Nebraska	Aug. —, 1867	36	.....	Seeds.
6	.....do.....	June —, 1868	31	.....	Seeds.
7	Wayne County, Nebraska	July —, 1869	.....	17	Seeds.
8	Fort Kearney, Nebraska	Oct. —, 1873	.....	24	Seeds.
9	.....do.....	Oct. —, 1874	38	.....	Seeds.
10	.....do.....	.....do.....	30	.....	Seeds.

CUPIDONIA CUPIDO, (Linn.) Bd.

Pinnated Grouse; Prairie Hen.

This grouse was formerly enormously abundant in Nebraska. Trapping them and hunting them with dogs has greatly reduced their numbers. They apparently eat insects whenever they can get them. The following are some of the examinations of this bird that I have made. Some maintain that there are more of them in the State now than at its first settlement, but as I was not in this Territory at that time I have no observations to depend on. Owing to the recently enacted laws forbidding the trapping of prairie chickens and quails, they have been slightly increasing for the last few years:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	Feb. —, 1865			Seeds and buds.
2	do	May —, 1865	43		do.
3	do	do	49		do.
4	do	June —, 1865	54		do.
5	do	do	58		do.
6	do	July —, 1866		47	do.
7	do	do		42	do.
8	Dixon County, Nebraska	Sept. —, 1867	55		do.
9	do	do	51		do.
10	do	June —, 1868	59		do.
11	do	do	57		do.
12	Wayne County, Nebraska	July —, 1869		60	do.
13	do	do		48	do.
14	Lancaster County, Nebraska	Sept. —, 1874	56	5	do.
15	do	do	61		do.
16	do	Oct. —, 1874	47	8	do.
17	do	do	53		do.
18	do	May —, 1875	48	3	do.
19	do	June —, 1875	62		do.
20	do	Sept. —, 1876	54	2	do.
21	do	do	59		do.

BONASA UMBELLUS, (Linn.) Steph.

Ruffed Grouse.

Rare in Nebraska. Have only seen one in the State and that in Richardson County in its southeastern corner. Failed to get this one. I place this grouse in the list of locust-eating birds only because of the known characters of its congeners.

Subfamily ODONTOPHORINÆ: AMERICAN PARTRIDGES.

ORTYX VIRGINIANA, (Linn.) Bp.

Virginia Partridge, or Quail; Bob White.

Common in Nebraska, but varies a great deal in abundance in different years. This is doubtless largely occasioned by the more or less destruction of them by the carnivora, and their allies, the sporting men. These birds also destroy great numbers of insects. I never opened one whose stomach did not contain more or fewer insects, as the following list of dissections shows:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	May —, 1865	31	8	Seeds.
2	do	do	20	11	do.
3	do	June —, 1865	37	4	do.
4	do	do	35	12	do.
5	do	do	33	10	do.
6	Dixon County, Nebraska	Sept. —, 1867	34	4	do.
7	do	June —, 1867	36	7	do.
8	do	do	29	6	do.
9	Dakota County, Nebraska	July —, 1868		38	do.
10	do	do		47	do.
11	do	do		39	do.
12	do	do		36	do.
13	do	do		40	do.
14	Lancaster County, Nebraska	Oct. —, 1874	37	10	do.
15	do	do	35	2	do.
16	do	do	39		do.
17	do	do	33	8	do.
18	do	do	31	11	do.
19	do	do	38		do.
20	do	do	34	4	do.
21	do	do	37	10	do.

Order GRALLATORES: Wading Birds.

Suborder LIMICOLÆ: Shore Birds.

Family CHARADRIIDÆ: Plover.

Subfamily CHARADRIINÆ: True Plover.

SQUATAROLA HELVETICA, (Linn.) Brehm.

Black-bellied Plover.

Occasionally seen in Nebraska. Two that were sent to me to identify from Sarpy County, in September, 1874, had their stomachs crowded with locusts, and very few other insects were present. I have only seen this plover on its migrations.

CHARADRIUS FULVUS VIRGINICUS, (Borck.) Coues.

American Golden Plover.

Have only seen this plover pass through Nebraska during its migrations, especially on its return in autumn. I procured no specimens during locust years, but four that were sent to me from Plattsmouth in October, 1872, had, among the insects, worms, etc., that crowded their stomachs, a great many grasshoppers, and no doubt they destroy great numbers of these insects.

ÆGIALITIS VOCIFERA, (Linn.) Bp.

Killdeer Plover.

Sparingly present in Nebraska. I have examined the following specimens to ascertain the nature of their food:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dixon County, Nebraska	May 28, 1865	37	21	A few grains.
2	..... do	..... do ...	39	8	
3	..... do	June —, ——	41	3	
4	Dakota County, Nebraska	... do ...	47	.....	
5	Wayne County, Nebraska	July —, 1869	.....	49	
6	... do	..... do ...	.....	46	
7	Pierce County, Nebraska	Aug. —, 1871	.....	51	
8	Sarpy County, Nebraska	Sept. —, 1874	49	4	
9	..... do	..... do	45	8	

ÆGIALITIS SEMIPALMATA, (Bp.) Cab.

Semipalmated or Ring Plover.

Abundant in Nebraska during its spring and fall migrations. The following are the only ones that I examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	May —, 1865	52	5
2	..... do	... do	40	13
3	Wayne County, Nebraska	Sept. —, 1868	.....	55
4	..... do	.... do	.....	59
5	..... do	.... do	.....	52
6	Sarpy County, Nebraska	Sept. —, 1874	58	2
7	..... do	..... do	54	5
8	..... do	..... do	60	.....
9	..... do	..... do	51	8
10	Richardson County, Nebraska	June —, 1875	49	12
11	..... do	..... do	59	1

ÆGIALITIS MELODA CIRCUMCINCTA, Ridgw.

Piping Plover; Ring Plover.

Common in Nebraska, and breeds here; at least, I found two nests in Dakota County, Nebraska, in July, 1866. Like the preceding, it seems to live wholly on insects. I have examined only the four following:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	May —, 1865	47	8
2	Wayne County, Nebraska	July —, 1868	.....	59
3	....do	....do	.....	56
4	Sarpy County, Nebraska	Sept. —, 1868	58	4

EUDROMIAS MONTANUS, (Towns.) Harting.

Mountain Plover.

Abundant in Nebraska, especially the western portions of the State. The following dissections show that it lives wholly on insects:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dixon County, Nebraska	July —, 1865	27	30
2	....do	....do	31	25
3	....do	Sept. —, 1866	.....	53
4	....do	Aug. —, 1867	54	6
5	....do	June —, 1868	59	3
6	Sarpy County, Nebraska	Sept. —, 1872	.....	62
7	....do	Sept. —, 1874	57	2
8	....do	....do	60	.....
9	....do	....do	58	4
10	....do	....do	51	9
11	Otoe County, Nebraska	June —, 1875	63	.....
12	Richardson County, Nebraska	....do	61	.....
13	Buffalo County, Nebraska	Sept. —, 1876	56	3
14	....do	....do	51	8
15	....do	....do	59	6
16	....do	....do	62	.....

Family RECURVIROSTRIDÆ: AVOCETS.

RECURVIROSTRA AMERICANA, Gm.

Avocet.

Found only abundantly in the vicinity of ponds, lakelets, and streams of water Two that I examined in September, 1874, near Bellevue, Sarpy County, had about an equal number of locusts and other insects in their stomachs. Obtaining their food generally in and near water, they naturally would capture fewer locusts than the preceding species. One that I obtained from Richardson County in September, 1873, had 71 insects of various kinds in its stomach.

Family PHALAROPODIDÆ: Phalaropes.

Steganopus wilsoni, (Sab.) Coues.

Wilson's Phalarope.

Common in Eastern Nebraska, though I obtained none for examination in locust years. But the following examinations show their highly insectivorous characters:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	July —, 1866	.....	58
2	.....do	.....do	.....	61
3	Dixon County, Nebraska	Aug. —, 1867	.....	54
4	.....do	Aug. —, 1868	.....	57
5	Sarpy County, Nebraska	Sept. —, 1873	.....	48
6	.....do	.....do	.....	56
7	.....do	June —, 1874	.....	59
8	Lancaster County, Nebraska	.....do	.....	62

Family SCOLOPACIDÆ: Snipes, etc.

Philohela minor, (Gm.) Gray.

American Woodcock.

Occasionally seen in Nebraska, and breeds here. I was fortunate enough to get two in September, 1874, from Sarpy County. Although locusts were abundant then, yet not more than a dozen of them were in their stomachs. But there was an enormous amount of other insects, larvæ, and worms in their stomachs. One, however, that was sent to me from Otoe County, in September, 1876, had 32 locusts in its stomach, besides a large number of other insects.

Gallinago wilsoni, (Temm.) Bp.

American Snipe; Wilson's Snipe.

Common in Nebraska during its migrations. This snipe lives largely on locusts when they can be obtained, as the following record indicates:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	May —, 1865	38	29
2	.....do	.....do	47	16
3	Cedar County, Nebraska	Aug. —, 1867	51	8
4	.....do	.....do	49	12
5	Lancaster County, Nebraska	June —, 1872	.....	59
6	.....do	.....do	.....	63
7	.....do	Sept. —, 1873	.....	54
8	.....do	Oct. —, 1874	57	6
9	.....do	.....do	60	5
10	Sarpy County, Nebraska	June —, 1875	51	12
11	.....do	.....do	59	3

MACRORHAMPHUS GRISEUS, (Gm.) Leach.

Red-breasted Snipe; Gray Snipe.

Abundant during its migrations. It, however, lives sparingly on locusts even when they are abundant.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dixon County, Nebraska	Aug. —, 1868	.....	61
2	..... do	.....do	.....	54
3	Wayne County, Nebraska	Sept. —, 1869	.....	58
4	Nemaha County, Nebraska	Oct. —, 1873	.....	60
5	.....do	.....do ...	21	43
6	Sarpy County, Nebraska	Sept. —, 1875	13	46

EREUNETES PUSILLUS, (Linn.) Cass.

Semipalmated Sandpiper.

Occasionally present in Nebraska during its migrations. I obtained none for examination during locust years. But from the known habit of its congeners I do not hesitate to place it in the list of locust-eating birds. Two that I examined on the Logan, in July, 1869, had their stomachs crowded with worms and water-insects and a few lilubella.

TRINGA MINUTILLA, Vieill.

Least Sandpiper.

Very abundant in Nebraska during its migrations. Mud-probers, like the preceding, they still indulge in locusts when they can get them. The following record clearly shows this:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Cedar County, Nebraska	Sept. —, 1867	22	17
2	.....do	.....do	25	10
3	.....do	.....do	18	22
4	Wayne County, Nebraska	Oct. —, 1869	.....	47
5	Sarpy County, Nebraska	Oct. —, 1874	27	18
6	.....do	.....do	21	28
7	.....do	.....do	15	34
8	.....do	.....do	19	37

TRINGA BAIRDI, Coues.

Baird's Sandpiper.

Rather common in Nebraska during its migrations. Like the preceding, it varies its diet, when that is possible, with locusts.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Sarpy County, Nebraska	Oct. —, 1873	.....	47
2	.....do	.....do	.....	43
3	Richardson County, Nebraska	Oct. —, 1874	15	25
4	.....do	.....do	12	34
5	.....do	.....do	18	24

TRINGA FUSCICOLLIS, Vieill.

Bonaparte's Sandpiper; White-rumped Sandpiper.

I have only occasionally seen this bird in Nebraska, and never obtained a specimen during locust years. I place it here only because of the known characters of its congeners.

TRINGA CANUTUS, Linn.

Red-breasted Sandpiper; Robin Snipe; Knot.

Occasionally seen in Nebraska. A single specimen sent to me to identify from Brownville, in October, 1874, had 11 locusts, besides a large number of other insects, in its stomach.

LIMOSA FEDOA, (Linn.) Ord.

Great Marbled Godwit.

Common in Nebraska, and breeds here. It does not disdain locusts when it can obtain them, though it never feeds exclusively on them, as this short record indicates:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Cedar County, Nebraska	Aug. —, 1867	10	34
2	do	do	13	32
3	Wayne County, Nebraska	Sept. —, 1869	.....	45
4	do	do	.....	41
5	Lancaster County, Nebraska	Sept. —, 1874	8	35
6	do	do	12	30

TOTANUS MELANOLEUCUS, (Gm.) Vieill.

Greater Telltale; Tattler.

Abundant in Nebraska, along rivers and creeks and lakelets, during its migrations. I secured no specimens during locust years, but the following is my record:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Wayne County, Nebraska	Sept. —, 1869	.....	48
2	do	do	.....	51
3	do	do	.....	46
4	Dakota County, Nebraska	Aug. —, 1870	.....	50
5	do	do	.....	47
6	Seward County, Nebraska	Sept. —, 1873	.....	52

TOTANUS FLAVIPES, (Gm.) Vieill.

Lesser Telltale; Lesser Yellowshanks.

Like the preceding and in similar situations. A few of these I obtained during a locust year from a sportsman at one time.

Number.	Locality.	Date.	Locusts in stomachs.	Other insects.
1	Lancaster County, Nebraska	Oct. —, 1874	9	40
2	do	do	17	22
3	do	do	4	41
4	do	do	14	25
5	do	do	16	28

TOTANUS SOLITARIUS, (Wils.) Aud.

Solitary Tattler; Wood Tattler.

Only seen in Nebraska during its migrations. Have seen the young in Dakota County during August, and therefore must occasionally breed here. Have only examined two specimens of this bird for the character of its food. One obtained from a sportsman in September, 1876, had 9 locusts and 34 other insects. The second, obtained from Seward County, in 1873, had only one grasshopper and 43 other insects in its stomach.

TRINGOIDES MACULARIUS, (Linn.) Gray.

Spotted Sandpiper.

Rather common in Nebraska, especially during its migrations, but many stop here to breed. Six, that I obtained from a sportsman, had indulged partly in a locust diet.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Lancaster County, Nebraska	May —, 1875	13	30
2	do	do	8	35
3	do	do	19	14
4	do	do	22	12
5	do	do	6	37
6	do	do	23	14

ACTITURUS BARTRAMIUS, (Wils.) Bp.

Bartramian Sandpiper or Tattler; Upland Plover.

Exceedingly abundant in Nebraska, especially during its migrations, but great numbers stop here to breed. It destroys enormous quantities of locusts and grasshoppers. Many suppose that it eats grains, but I have never found any in its stomach. The following are a portion of those that I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.
1	Dakota County, Nebraska	May —, 1865	40	10
2	do	do	33	17
3	do	do	42	12
4	do	June —, 1855	37	9
5	do	do	36	11
6	do	do	44	7
7	do	do	40	13
8	do	do	38	16
9	Dixon County, Nebraska	Aug. —, 1867	47	4
10	do	do	43	10
11	do	do	49	3
12	do	do	50	5
13	Wayne County, Nebraska	Sept. —, 1869	8	43
14	do	do	12	41
15	do	do	10	38
16	Lancaster County, Nebraska	Sept. —, 1872	.....	55
17	do	do	.....	51
18	do	Sept. —, 1874	58	.....
19	do	do	52	4
20	do	do	57	5
21	do	May —, 1875	60	.....
22	do	do	51	7

TRYNGITES RUFESCENS, (Vieill.) Cab.

Buff-breasted Sandpiper.

Rare in Nebraska. The single specimen that I obtained from a sportsman in September, 1874, at Nebraska City, had 42 locusts and a few other insects in its stomach.

NUMENIUS LONGIROSTRIS, Wils.

Long-billed Curlew.

Formerly abundant in Nebraska, and still is in some sections and where not disturbed by gunners. It breeds here. Its diet is more varied than that of the preceding species of this family, but still depends principally on insects, as the following examinations of specimens show:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Cedar County, Nebraska	Sept. —, 1876	54	16	
2	do	do	58	15	11 seeds.
3	Dixon County, Nebraska	June —, 1868	65		17 seeds.
4	do	do	51	9	14 seeds.
5	Dakota County, Nebraska	Aug. —, 1869		61	13 seeds.
6	do	do		53	20 seeds.
7	Sarpy County, Nebraska	Sept. —, 1874	69		8 seeds.
8	do	do	63	4	7 seeds.
9	Seward County, Nebraska	May —, 1875	70		9 seeds.
10	do	do	53		24 seeds.

NUMENIUS HUDSONICUS, Lath.

Hudsonian Curlew.

Rare in Nebraska. Have seen it but twice and obtained no specimens. I place it in this list because of the known habits of its congeners.

NUMENIUS BOREALIS, (Forst.) Lath.

Esquimaux Curlew.

I have only seen this curlew in early spring and in October in Northeastern Nebraska during its migrations. One that was sent to me from Bellevue to identify, in October, 1874, had 31 locusts and a large number of small berries of some kind in its stomach.

Suborder HERODIONES: HERONS AND THEIR ALLIES.

Family ARDEIDÆ: HERONS.

ARDEA HERODIAS, Linn.

Great Blue Heron.

Occasionally seen in Nebraska. One that was killed in August, 1871, on the banks of the Missouri, four miles below Dakota City, had 11 grasshoppers, fish, and some frogs in its stomach.

HERODIAS EGRETTA, (Gm.) Gray.

Great White Egret; White Heron.

I saw a single specimen of this bird on the Nemaha in Richardson County, Nebraska, in May, 1873, but never obtained one. I place it in this list because of the known characters of its congeners.

GARZETTA CANDIDISSIMA, (Gm.) Bp.

Little White Egret; Snowy Heron.

Very rarely seen in Nebraska. I met with it myself only twice, in Otoe and in Richardson County on the Missouri. Only from the known habit of its family is it mentioned here.

BOTAURUS MINOR, (Gm.) Boie.

American Bittern.

Occasionally seen in Nebraska. One that was sent to me from Grand Island, Nebr., to identify, in September, 1873, had 16 grasshoppers in its stomach. For some reason that I cannot now recall I did not mention in my note-book the character of its remaining food. Coues says that its food is mollusks, crawfish, frogs, lizards, small snakes, fishes, and insects.

Suborder ALECTORIDES: CRANES, RAILS, ETC.

Family GRUIDÆ: CRANES.

GRUS AMERICANA, (Linn.) Temm.

White or Whooping Crane.

Occasionally seen in Northern Nebraska. I place it among the list of locust-eating birds because of its known habits and because of the characters of the next species, to which it seems to be nearly related, though I have obtained no specimens for examination.

GRUS CANADENSIS, (Linn.) Temm.

Sandhill Crane.

Rather abundant in Nebraska. The following I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Cedar County, Nebraska	Aug.—, 1867	71	48	Seeds.
2	Dixon County, Nebraska	July —, 1868	37	78	Seeds.
3	Seward County, Nebraska	June —, 1875	80	36	Seeds.
4	Sarpy County, Nebraska	Sept. —, 1876	75	40	Seeds.

Family RALLIDÆ: RAILS.

RALLUS ELEGANS, Aud.

King Rail; Fresh-water Marsh Hen.

I have only met with this bird in Southern Nebraska. The following are the only specimens that I obtained for examination:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Harlan County, Nebraska	Aug.—, 1874	38	31	Seeds.
2	....do	.....do	44	20	...do.
3	Sarpy County, Nebraska	Oct. —, 1874	19	41	...do.
4	.....do	.....do	42	27	...do.
5	Lancaster County, Nebraska	.....do	36	30	.. do.
6	.....do	....do	17	49	...do.
7	.....do	May —, 1875	48	14	...do.

PORZANA CAROLINA, (Linn.) Cab.

Carolina Rail; Ortolan.

Have seen this bird but once in Nebraska. This was in September, 1869, near Dakota City, Nebraska. I failed to get a specimen, and place it in this list because of the habits of its congeners.

PORZANA JAMAICENSIS, (Gm.) Cass.

Little Black Rail.

Rare in Nebraska. I saw two, one of which I procured by the kindness of a gentleman who shot it. This was in Richardson County, Nebraska, in September, 1873. It had 11 grasshoppers and 27 other insects and a quantity of seeds and vegetable matter in its stomach.

GALLINULA GALEATA, (Licht.) Bp.

Florida Gallinule.

Have never seen this bird alive in Nebraska, but one was sent to me from Beatrice in September, 1872, to be identified. It had 7 grasshoppers, 29 other insects, and some seeds and vegetable matter in its stomach.

FULICA AMERICANA, Gm.

American Coot; Mud Hen.

These birds, while not abundant, are often seen in Nebraska. Their food is indicated by an examination of the following specimens:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	May —, 1865	37	15	Fresh-water mollusks.
2	do	do	31	29	do.
3	Dixon County, Nebraska	June —, 1865	.....	44	do.
4	do	do	.....	40	do.
5	do	Sept. —, 1867	49	10	do.
6	Lancaster County, Nebraska	Sept. —, 1871	.....	57	do.
7	do	do	.....	51	do.
8	do	May —, 1875	54	12	do.
9	do	do	43	20	do.

Order LAMELLIROSTRES: ANSERINE BIRDS.

Family ANATIDÆ: SWANS, GEESE, AND DUCKS.

CYGNUS BUCCINATOR, Rich.

Trumpeter Swan.

Rare in Nebraska. I have only seen it twice alive since I am in the State. I place it in this list only because of the known habits of its congeners.

ANSER HYPERBOREUS, Pall.

Snow Goose; White Brant.

Abundant in Nebraska during its migrations. It seems to be omnivorous, as the following examinations indicate:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	April —, 1865	.....	49	Shells and grass.
2	do	do	.....	57	do.
3	Lancaster County, Nebraska	Oct. —, 1871	30	26	do.
4	do	do	21	37	do.
5	do	Oct. —, 1874	60	7	do.
6	do	do	52	28	do.
7	do	do	57	15	do.
8	do	do	21	44	do.

Numbers 3 and 4 of the above must have brought the locusts that were in their stomachs from the far north as there were few about in this locality at the time. There can be no doubt, from the food of the above, that when these geese occupy locust regions, they must destroy vast numbers of these insects

BRANTA CANADENSIS, (Linn.) Gray.

Canada Goose; Common Wild Goose.

Very abundant in Nebraska, and occasionally breeds here. After the great mass have passed north in April, I have sometimes later in the season seen young ones along the Missouri. It will be seen that some of the geese mentioned in the following list had locusts in their stomachs in other than locust years. In such cases, they must have

procured them in higher latitudes. In every instance of this kind, the locusts had been so long in their stomachs that the number mentioned was counted with difficulty.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	Apr. —, 1866	.....	69	Mollusks and grass.
2	do	do	.....	60	do.
3	Lancaster County, Nebraska	Oct. —, 1871	41	33	do.
4	do	do	20	44	do.
5	do	do	33	49	do.
6	do	Oct. —, 1872	11	65	do.
7	do	Oct. —, 1874	68	15	do.
8	do	do	70	10	do.
9	do	do	36	40	do.

Anas boschas, Linn.

Mallard.

Very abundant in Nebraska during its migrations. Many also breed here. Omnivorous apparently. Owing to its aquatic habits it does not destroy as many locusts as would naturally be expected. The following list shows the food eaten in Nebraska:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dixon County, Nebraska	Apr. —, 1865	.....	46	Mollusks, etc.
2	do	do	.....	28	do.
3	Dakota County, Nebraska	June —, 1865	41	10	do.
4	do	do	49	12	do.
5	do	do	21	40	do.
6	Lancaster County, Nebraska	Oct. —, 1873	8	37	do.
7	do	do	.....	21	do.
8	do	Oct. —, 1874	45	8	do.
9	do	do	48	11	do.
10	do	do	12	47	do.

Anas obscura, Gmelin.

Dusky Duck; Black Duck.

Occurs sparingly in Nebraska. The only specimen that I obtained I purchased at a meat-shop in Lincoln in October, 1874. It had 16 locusts, 30 other insects, and some grass and seeds in its stomach.

Dafila acuta, (Linn.) Jenyns.

Pintail; Sprigtail.

Rather common in Nebraska, especially during its migrations. In this latitude is so much confined to the water that it eats sparingly of locusts.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Sarpy County, Nebraska	Oct. —, 1873	13	40	Mollusks, etc.
2	do	do	2	31	do.
3	do	Oct. —, 1874	20	25	do.
4	do	do	13	38	do.
5	do	do	17	33	do.
6	do	do	11	36	do.
7	do	do	6	40	do.

QUERQUEDULA CAROLINENSIS, (Gm.) Steph.

Green-winged Teal.

Very abundant in Nebraska during its migrations. It also consumes locusts, though I have not examined any during locust years. Those, therefore, that I found in the stomachs of the following specimens must have been obtained in higher latitudes. They were so macerated already that they were identified with difficulty. I obtained these ducks mostly from sportsmen.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Sarpy County, Nebraska	Sept. —, 1871	12	43	Small mollusks, etc.
2	do	do	4	50	do.
3	do	Oct. —, 1871	.....	41	do.
4	do	do	.....	46	do.
5	Cass County, Nebraska	Sept. —, 1873	15	21	do.
6	do	do	2	30	do.
7	do	do	11	27	do.
8	Lancaster County, Nebraska	Oct. —, 1873	.....	38	do.
9	do	do	.....	43	do.

QUERQUEDULA DISCORS, (Linn.) Steph.

Blue-winged Teal.

Not as abundant as the preceding in Nebraska. A single one that I examined in Dixon County, Nebraska, in October, 1867, had 37 locusts, 22 other insects, and some small fresh-water mollusks and seeds in its stomach.

SPATULA CLYPEATA, (Linn.) Boie.

Shoveller; Spoonbill Duck.

Occasionally met with in Nebraska. One that I obtained in Dixon County in May, 1865, had 32 locusts, 28 other insects, a few seeds, and some small mollusks in its stomach.

AIX SPONSA, (Linn.) Boie.

Summer Duck; Wood Duck.

Rather abundant in Nebraska, and breeds here. It varies a great deal in its habits of eating different kinds of insects, as the following record indicates:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dixon County, Nebraska	May —, 1865	4	33	Small mollusks, etc.
2	do	do	30	7	do.
3	Dakota County, Nebraska	June —, 1865	38	4	do.
4	do	do	10	30	do.
5	Wayne County, Nebraska	Aug. —, 1869	.....	47	do.
6	do	do	.....	43	do.
7	Seward County, Nebraska	Oct. —, 1873	.....	20	do.
8	Lancaster County, Nebraska	Sept. —, 1874	48	.....	do.
9	do	do	8	30	do.

The Red-head and Canvas-back Duck are rather frequently seen in Nebraska, but I never made any examination of their stomachs, and place them in this list because of the known habits of their congeners.

BUCEPHALA ALBEOLA, (Linn.) Bd.

Butter-ball; Dipper; Spirit Duck.

Frequently seen along the Missouri and its tributaries in Nebraska. The following I have examined:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	May —, 1868		37	Seeds and mollusks.
2	do	May —, 1868		21	do.
3	Dixon County, Nebraska	May —, 1869		30	do.
4	Lancaster County, Nebraska	May —, 1875	40		do.

ERISMATURA RUBIDA, (Wils.) Bp.

Ruddy Duck.

Rather common along the Missouri during its migrations. One that I obtained from Sarpy County, in October, 1874, had 31 locusts, 20 other insects, and some small fresh-water mollusks in its stomach.

There are still other ducks frequenting the waters of Nebraska, but as I have not examined the contents of their stomachs I will not enumerate them here. Evidently, however, all the ducks will destroy more or less locusts and vast numbers of aquatic insects.

Order STEGANOPODES: TOTIPALMATE BIRDS.

Family PELECANIDÆ: PELICANS.

PELECANUS TRACHYRHYNCHUS, Lath.

White Pelican.

Frequently seen in Nebraska during its migrations. The following record shows that it also likes to vary its diet with locusts:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Lancaster County, Nebraska	May —, 1872		40	Crawfish and fish.
2	do	May —, 1872		21	do.
3	do	May —, 1873		33	do.
4	do	May —, 1875	67		do.
5	do	May —, 1875	41		Crawfish, fish, and frogs.

Order LONGIPENNES: Long-winged Swimmers.

Family LARIDÆ.

Some members of this family I did not succeed in identifying, and they are therefore left out of this list. The numbers present in Nebraska vary a great deal in different years.

STERCORARIUS POMATORHINUS, (Temm.) Vieill.

The Pomarine Jaeger.

I only saw this bird alive once. It was on the Missouri, in Dakota County, in May, 1869. One that was shot on the Platte near Fremont in May, 1873, was sent to me to be identified. It had a few grasshoppers and a mass of the remains of crawfish, frogs, and a fish in its stomach.

LARUS MARINUS, Linn.

Great Black-backed Gull.

I only saw this bird once in Nebraska, and then it was dead. Some Winnebago Indians brought one to Dakota City in May, 1871. They had shot it on the Missouri.

Its stomach contained a few grasshoppers and other insects, but the great mass seemed to be made up of fish and frog.

LARUS ARGENTATUS, Brünn.

Herring Gull.

I was fortunate enough to get two of these gulls from the Winnebago Indians in May, 1870. One had 2 and the other had 11 grasshoppers in its stomach, and each had besides remains of fish and small mollusks mingled with these insects.

LARUS DELAWARENSIS, Ord.

Ring-billed Gull.

Rather common in Nebraska. Its food seems to vary wonderfully; at least the individuals that I obtained for examination had great diversity of materials in their stomachs.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	May —, 1867	.....	33	Crawfish and frogs.
2	.....do	.....do	.....	.....	Crawfish and fish.
3	.....do	May —, 1868	.....	15	Fish, frogs, and mollusks.
4	Dixon County, Nebraska	June —, 1868	40	.....	Small mollusks.
5	Sarpy County, Nebraska	May —, 1873	.....	10	Fish and crawfish.
6	.....do	.....do	.....	27	Crawfish and mollusks.

LARUS (CHROCOCEPHALUS) FRANKLINI, Rich.

Franklin's Rosy Gull.

Large numbers here during the spring and fall migrations. Like the preceding, it seems to eat whatever it can get. The following record indicates its omnivorous character:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Dakota County, Nebraska	May —, 1868	.....	22	Frogs, fish, and a lizard.
2	....do	.....do	.....	12	Frogs, fish, and snails.
3	Wayne County, Nebraska	May —, 1869	.....	.	Snails, fish, etc.
4	.....do	.....do	.....	39	Fish, frogs, and crawfish.
5	Sarpy County, Nebraska	May —, 1875	48	.....	Fish and frogs.
6	.....do	.....do	34	4	Fish, frogs, and crawfish.
7	.....do	.....do	41	.....	Mollusks and fish.
8	Cass County, Nebraska	May —, 1877	13	29	.....do
9	.....do	.....do	53	....	.....do
10	.....do	.....do	26	4	.....do

STERNA FORSTERI, Nutt.

Forster's Tern.

I obtained no specimen of this tern during locust years, and the two that I dissected in Dakota County, Nebraska, in May, 1871, were obtained from some Winnebago Indians. One had 3 and the other 14 grasshoppers, and both had the remains of fish, crawfish, and a lizard in their stomachs.

STERNA MACRURA, Naum.

Arctic Tern.

Only saw a few of these terns in Dixon County, in May, 1866. I place it in this list only because of the characters of its congeners.

STERNA SUPERCILIARIS ANTILLARUM, (Less.) Coues.

Least Tern.

Rather common in Nebraska. It must breed here; at least, I saw young ones in the Missouri Bottom in Dixon County, in July, 1866. My record of examinations indicates that this tern is a good locust-eater.

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Cedar County, Nebraska	Aug. —, 1867	37	3	Crawfish and frog.
2	do	do	49		do.
3	Dixon County, Nebraska	June —, 1868	44		do.
4	do	do	23	10	Crawfish and fish.
5	Sarpy County, Nebraska	June —, 1872		47	Crawfish and frog.
6	do	do		4	do.
7	Lancaster County, Nebraska	June —, 1873		38	Fish, frog, and snails.
8	do	June —, 1874		22	do.

HYDROCHELIDON LARIFORMIS, (Linn.) Coues.

Black Tern.

Some years rather common, and other years rare in Nebraska, but breeds here, as I have seen its young in July on the Elkhorn. The following is my record:

Number.	Locality.	Date.	Locusts in stomach.	Other insects.	Other food.
1	Pierce County, Nebraska	July —, 1869		28	Crawfish.
2	do	do		59	do.
3	Lancaster County, Nebraska	Sept. —, 1874	60		
4	do	do	47	4	Snails and frog.
5	Sarpy County, Nebraska	May —, 1875	58		Snails and lizard.
6	Richardson County, Nebraska	Sept. —, 1876	64		

Order PYGOPODES: DIVING BIRDS.

Family PODICIPIDÆ: GREBES.

PODICEPS AURITUS CALIFORNICUS, (Heerm.) Coues.

American Eared Grebe.

Rather abundant in Nebraska, especially on the Platte and the Missouri. One that I obtained from Columbus in September, 1874, had 9 locusts, a little grass and some seeds, and a large amount of crawfish in its stomach. Another one sent to me from the Missouri, near Bellevue, had 5 grasshoppers, a few other insects, a part of a fish, and some crawfish in its stomach.

APPENDIX III.

TEXAS DATA FOR 1877.

REPORT OF JACOB BOLL, SPECIAL ASSISTANT, DALLAS, TEXAS.

Taylor, Williamson County, Texas.

MAY 18, 1877.

Country not well settled. I could not detect any damage caused by locusts. Prairie land was in excellent condition and covered with flowers.

Round Rock, same county, well settled. Damage not important, and limited to gardens. The majority of locusts were already gone, and only a few remained. The larvæ traveled in the direction of the northwest. Ten years ago the same place was visited by locusts.

Limestone County.

MAY 19, 1877.

This county, consisting only of prairie, was damaged to a considerable extent. Seven-eighths of the first corn crop gone. In spring all the cultivated land was invaded by locusts from the southern side. With the exception of the cotton-boll worm, which caused some damage three years ago, the fields have not suffered at all for six years past.

MAY 21, 1877.

During the passage from Houston to San Antonio the crop was everywhere in good condition; no damage by locusts could be observed, whether on sugar-cane, corn, or cotton. I saw no wheat cultivated on the road.

San Antonio, Bexar County.

MAY 22, 1877.

The proprietor of a farm of twelve hundred acres, six miles south of San Antonio, informs me that his first crop of corn was partially destroyed. The locusts laid their eggs in the fall on uncultivated ground outside the farm. The young invaded the farm this spring from the southeast, but they only traveled by certain lines in masses in a northwest direction. The greater part of the damage was limited to the garden.

MAY 28, 1877.

Surrounding country not very much cultivated; the valley can be irrigated. Martin Engelman, a farmer and nurseryman, living one mile northeast from the city for twenty-six years, stated that the locusts laid eggs on the outside of his farm in dry, firm, black soil; when hatched they crossed the water-ditch, entered the farm from the southeast, and took the direction to northwest, in which direction the winged started about four weeks ago. In uncultivated land fewer locusts were observed. They destroyed all the vegetables, the vines, peach-trees, &c., and left the corn untouched in the wesern part of his farm. The damage was more limited to his garden. A week after they left his place all was green again, and I observed the vines full of large grapes and the peach-trees full of fruit. Some of the latter were killed. The vegetables in the garden were in such a condition that no damage could have been detected.

In general, the damage around San Antonio was more in gardens; on the southeast side of the city the gardens were not touched at all, and in some places on the river, where the blue-grass from Kentucky has been cultivated, the locusts preferred it especially. All informants agree that they appear every eighth or tenth year.

New Braunfels, Comal County.

JUNE 6, 1877.

Mr. Kessler, a farmer, who has over 1,000 acres in cultivation two miles south, says the eggs were laid in hard prairie land and in sand, rather than in black soil. Direction of the travel of the larvæ, north northwest. On the right side of the Guadalupe River, running southeast, they were more numerous than on the left side. In a field which is crossed from south to north by a fence, the locusts moved along on both sides of the fence, destroying the corn for a distance of 20 feet. The remaining part of the field

was not touched. A considerable part of the larvæ were killed by the *Tachina* fly. Ten years ago they had an invasion of locusts. He observed then that they died in very large numbers, but not so much through parasites as from change of weather, which became moist and cold. When the winged insects came at the same invasion, they destroyed every green thing, and even the cotton curtains on the windows.

JUNE 7, 1877.

Mr. Lindheimer, the celebrated botanist, was the only man of whom I could get some exact dates. He stated that the locusts arrived the 10th of October, 1876, noon, with northwest wind. On the 15th every green thing was destroyed, and egg-laying was beginning. On October 20, they nearly all left in a southerly direction, with a strong wind. At the end of February, the eggs hatched. May 1, the winged insects left, going northwest, and on the 15th of May they had disappeared entirely. The damage from locusts in 1858 was considerable.

Cypress City, Harris County, 25 miles northwest of Houston.

JUNE 13, 1877.

Locusts were not observed at any time at this place, on the testimony of the following farmers: Gerloff, 24 years here; Bergstädt, 25 years here; Muller, 30 years here.

A few locusts have been observed at Houston, doing very little damage; but many at Hempstead, 26 miles northwest from Cypress City. On this place, the principal plants under cultivation are corn, cotton, and oats.

Report from Fort Worth, Tarrant County.

JULY 1, 1877.

The country not very settled. The Cretaceous formation is covered everywhere by Tertiary formation. The lower cross timber runs about 10 miles wide along the western limit of the county. The whole county suffered considerably in the sandy regions from locusts. Eggs were laid in large quantities in the small open prairies of the cross timber, and on the bluff about 200 feet high on the south side of the West Fork River.

The direction of the traveling larvæ was northwest. Many farmers had to replant corn two or three times. I observed myself in the beginning of April all small trees and bushes of elm covering the bottom of the West Fork entirely deprived of foliage by locusts.

The damage in wheat for the county is estimated to average half of the crop, but some farms situated in the open prairie were quite free from damage.

The winged locusts left in the first days of May, going northwest. In general, nothing was done against them, and as they appear only every eight or ten years, people don't much fear them.

Reply to the questions of the U. S. Entomological Commmission, Bulletin No. I.

1. Arrival of locusts in Dallas, September 20, 1876, 12 o'clock.

1*a*. Wind from northwest, moderate.

1*b*. Warm and clear.

1*c*. Southeast, very dense; the height of the swarm estimated at 2,000 feet, its extension in breadth from 40 to 60 miles.

2. September 21, arrival of new swarms, 10 o'clock a. m., with the same direction and strength of wind; only a few alighted. The passage continued till 4 o'clock p. m. On the 22d of September there was no wind and no new swarms arrived. September 23d, at noon, a great quantity of locusts started in the direction of northwest, whilst we had southwest wind. The weather was fair and warm. Till the 5th of October they stayed here in the same number, and diminished from then partially by going southward, partially by being devoured by prairie chickens (*Tetrao cupido*), but only toward the end of October did they entirely disappear.

3. Coupling commenced on the 25th and became general on the 30th of September. The first eggs were deposited on the 29th.

4. The first hatching of the eggs I observed on February 26, 1877, in sand, especially on places where the sun was shining. The hatching became general from the 2d to the 10th of March, 1877. It continued, however, until the 20th. The hatching was in close relation to the temperature; only a few hatched on cold days. The most hatched a day after rain.

5. Could not be observed.

6. About one-third of the eggs did not hatch; those were probably destroyed during the winter by insects, birds, and by plowing of prairie.

7. The eggs were generally deposited in hard and sandy soil, and on places where the grass was wanting, in the tracks of old roads, &c., and in free and open places in timber. More eggs were deposited in sand than in black soil.

8. In sandy soil they seem to be hatched more numerously than in black soil and also where it was most sunny.

9. I found the first winged locusts on the 5th of April.

10. The first started May 3, in considerable numbers.

11. The damage in Dallas County and the State; is estimated at one-third for wheat and at one-half for corn. The latter, however, could be replanted; therefore the damage, in consequence of favorable weather, was reduced on more work.

12, 13, 14. Wheat suffered most, then corn; grass, and barley were seldom touched, and as cotton was not planted before the locusts left the country, it was not damaged at all. Against it grape-vines, peaches, and other fruit-trees suffered considerable. Potatoes, cabbage, lettuce, &c., were nearly all destroyed by the young locusts, as in the fall previously by the winged ones. Remarkably enough, they did not touch the sweet potatoes.

15. After my own minute observation, the unwinged locusts moved from southwest to northeast; fences, creeks, &c., changed somewhat that direction. The very young ones assembled already in very thick masses. After they consumed the scarcely developed leaves of the lower plants, I saw them eat also dry leaves on the bottom; then they climbed on dry stalks and consumed the old leaves. They migrate nearly always after each transformation, and the more they grow the more they travel. Every farmer I consulted confirmed me that their fields were entered every time from the south side, with more or less deviation according to the obstacles, but never from the north side. The newly winged insects don't eat anything before their departure; from three to five days elapse before they start when they are winged, as it requires a certain time for the wings to get strong.

16. Means for the destruction of the unfledged insects were very little resorted to. I did not hear that farmers made ditches around their cultivated land, nor do they employ machines. Newspapers mentioned from New Braunsfels that there a machine was used. But when I got information about it, I understood that eight or ten years ago somebody invented one and used it in gardens, but that was all. In gardens, people used brooms against the locusts, and burnt them with dry hay and straw, but almost without any good result. More was effected by small chickens; hens with their young ones protected the crop in the gardens to a certain extent. Some farmers protected their fruit-trees by twisting a piece of cotton around the stem or putting tar on it.

17. No means were employed for the destruction of the winged insects. After their arrival in fall, wheat, corn, barley, oats, &c., were already secured, and the cotton ripe nearly all over, so that farmers told me that the cotton-picking was much easier, as the locusts ate the leaves up.

20. In October, 1874, swarms of insects came to Dallas, but only one-tenth as much as in 1876. In spring, 1875, the young locusts did not do any damage.

21. The following wild birds are especially very useful in the destruction of locusts: *Charadrius virginicus* (Plover), *Charadrius montanus* (Mountain Plover), *Cupidonia cupido* (Prairie Chicken), *Meleagris gallopago* (Turkey), *Ortyx virginiana* (Quail), *Numenius longirostris* (Curlew), the common domestic fowl, hogs and opossums, especially insects of prey, *Tachinæ*, &c.

As the locusts only appear here at intervals of eight or ten years, it is not surprising that they are not much feared by the inhabitants of this State.

It is difficult to obtain satisfactory or authentic information, as no special attention was given by any one to the observation of locusts.

DALLAS, TEXAS, *August* 12, 1877.

MISCELLANEOUS REPORTS.

Notes from Dallas County previous to the year 1877.

[By J. Beverschau.]

I came to this county February, 1856. The fall previous a great number of grasshoppers made their appearance, destroying by the way all green vegetation; in a field of wheat of about 30 acres not a blade of it could be seen in February, but in March the wheat began to grow again, and, if my recollection is correct, 12 or 15 bushels to the acre was made out of that field. The grain was of good quality. I don't think they deposited any eggs. I don't remember having seen any young 'hoppers the next spring, or hearing there were any.

From that time, I believe hardly a year has passed without grasshoppers in the fall, but these in so small a quantity as to excite no alarm among the farmers except in the following years.

In the fall of 1867 much was said about immense swarms of locusts advancing both from west and north. They made their appearance at Weatherford, in Parker County, two months before they came here. The following is from my note-book:

October 15.—Wind south and light. Legions of 'hoppers at noon; traveling eastward. They were not high in the air, but flying low on the prairie, alighting frequently and

starting again. On the 18th their number increased doubly, traveling in the same direction, with the wind blowing in the same direction. They eat everything tender, even the leaves of peach-trees, and at night the trees, houses, and walls were literally covered with them.

October 21.—Wind from the north. At about 2 o'clock p. m., swarm upon swarm darkens the sky, traveling south, and very high. At night a great number alight.

After that date they diminish daily, traveling always east or south, as the wind allowed them to do.

On the 4th of November, a light rain having moistened the ground (before that we had a protracted drought), they began to deposit their eggs in immense quantity, and continued to do so about al this month, at the end of which they had nearly all disappeared. As the fall has been very dry, no wheat was sowed before the appearance of grasshoppers, and the presence of the insects delayed the sowing until about the middle of November; so no fall-wheat was damaged.

1868, *February* 22—I observed the first 'hoppers hatching in a warm dry place. Since March 3, great numbers hatch out, and continue to hatch for a month after. In the valley where the water had stood several days on the ground, some 'hoppers hatch very late, after the ground begins to dry up.

March 29.—They congregate in bushes along the branches, and seem traveling northward.

April 10.—They are coming out of the covers and in fields, where they commit great depredations.

April 14.—Traveling very much.

April 15.—Follow down the branches.

April 16.—Seem to follow the back track of yesterday.

April 26.—See numbers dead—more than half-grown.

April 30.—See a few with wings.

May 10.—A good many got wings.

May 15.—They begin to leave, flying in a northward direction; the wind blowing from the south. At the end of the month about all have disappeared.

I think most of the eggs deposited in the fall hatch out. The ravages were mostly confined along the branches, where the 'hoppers seemed seeking a shelter for their transformations. In such situations, entire patches of oats and corn were destroyed generally. The wheat was but little injured, and as we had abundant rain in the spring and summer, the year proved to be a good one for grain, vegetables, cotton, and fruits.

1874, *September* 14.—At about 1 o'clock p. m., wind blowing lightly from the north, immense swarms of grasshoppers made their appearance, alighted, and destroyed all the young vegetation, and injured the fall-wheat to some extent; all this month they laid countless millions of eggs, about as many as in 1867; at the end of this month the most had disappeared, traveling always in a southern or western direction.

1875.—It was the 10th of March when the young 'hoppers began to hatch, but I don't think now that more than the third of the quantity deposited in the fall hatch out; some seem to have rotted in the ground, and a good many were probably destroyed by insects of the *Carabidæ* family. I have seen an *Evarthrus gravidus* eating some.

In spite of that, immense legions of young pests swarmed on all the dry places of the prairie, and great destruction of crops was expected. Fortunately, great flocks of birds, appearing nearly at the same time, made a terrible havoc among them. I have seen fields covered with such numbers of grasshoppers as to leave no hope for crop whatever entirely cleared out in one day by these useful birds; and this is the place to say a word or two about them. The first to put in appearance, and very often traveling together, are the curlew (*Numenius borealis*) and the golden plover (*Charadrius virginius*). Soon after these have left for more northern latitudes, a third species, called also (although improperly) plover, arrives, and often covers the prairie in small flocks, and rendering always good service, because it stays with us till the grown 'hoppers have left. The scientific name of that species is *Arcituras bartramius*. The quantity of young 'hoppers eaten up by these three kinds of birds only is truly amazing; nevertheless, a good many are killed every spring by sportsmen and poachers. A law for the protection of all the insectivorous birds would be a blessing for the farmers, and will help materially to lessen the number of noxious insects.

That year the 'hoppers did but little damage; they began to get wings in May, but I think the most died just after they had wings. I have seen piles of them along the bluffs.

In the fall of the same year they appeared again in limited numbers, but did no damage, and deposited no eggs.

Answers to the questions in Circular 1. *Dallas County.*

1. September 19, at 11 o'clock, a. m.

1*a*. Moderate, north.

1*b*. Smoky, but not cloudy; warm.

1c. South; very thick; extended as far as the eye could reach: very high.
2. Cannot answer properly; some leaving and more coming every day; but the most left about October the 10th.
3. Began the 24th of September; laid immensely during two or three weeks.
4. Saw the first the 2d of March, 1877, and continued for over a month.
5. Seems to me that nearly half did not hatch out: some *Carabidæ* ate a good many; hear it said that the prairie chickens have scratched out and destroyed a good many.
6. In all rocky and dry places along the roads, and in denuded but hard places on the prairie; don't deposit any eggs in plowed or soft ground.
7. April 24.
8. May 5.
9. Suppose, in my immediate neighborhood, at about a third.
10. First, spring-oats; second, barley; third, wheat; fourth, Indian corn.
11. Don't know.
12. The Indian corn, except when they are starving; they hardly touch the English peas and sweet-potatoes.
13. Could not see that they were marching in any positive direction, seemed to be going from the prairie to the branches and from the branches to the prairie: they seemed to be hunting covers to cast their skins; when the wheat and other crops are high enough, they stay in permanently until they get wings.
14. None that I know of; except a few farmers burning them, in scattering straw on their hatching-places, but that amounts to little. I have employed satisfactorily young chickens; 300 of them protected me about two acres of ground, planted in oats, Irish potatoes, asparagus, &c.
15. Not any.
20. Nearly every fall by a few; but immense swarms appeared in 1855, 1867, and 1874.
21, 22. I can say nothing satisfactory about these questions.

Mount Calm, Limestone County, *March* 10, 1877.—Having seen a notice in your paper of February 24 that barley was six inches high in California, I thought that perhaps you would like to know how it was doing in Texas. I went into a field of barley March 5 that I sowed in October, and found some of the largest blades measured eighteen inches. My wheat sowed in November measured eleven inches. The prospect for a small-grain crop is very good. Corn crop not yet in the ground in this section, owing to the recent rains. Grasshoppers hatching out by the million on the sandy land. I live on black land, and have not yet seen any eggs or 'hoppers, nor have I heard of any on black land. Good land in this section sells from $3 to $6 per acre. Improved lands rent readily from $4 to $5 per acre.—[John Fogarty, in *Prairie Farmer*.

I will answer your questions *seriatim* as well as I can from the information at present at my command: 1. "Area invaded."—The entire State, with the exception of the eastern or heavily timbered portion. 2. "Date of arrival."—About midday on the 20th of September. 3. "Main direction of flight and wind."—Southeast, with wind in same direction. After their first appearance here they remained some three weeks, and then the major portion departed in the direction named. Two weeks subsequently they returned in considerable numbers from the southeast, the direction of their original departure. Their eggs were chiefly deposited after their last appearance. 4. "The area over which eggs have been laid."—So far as I am informed, over the whole State, with the exception mentioned in question first. Our State journals have been reporting the hatching of the eggs during the past four weeks. In this locality, myriads of young locusts are visible. Already early gardens have been destroyed. Will they probably damage our wheat and other crops?—[John H. Stevens, Dallas, March 18, 1877.

Wheelock, Robertson County, *March* 21.—Farmers have their ground prepared ready for planting. Some have finished, and the corn is up and looking well. Others are holding back on account of the grasshopper. There are millions upon millions of the little imps already hatched out. They have done no great damage as yet. Looking for them to leave every day. No restraint or welcome extended. Joy go with them.—[T., in *Prairie Farmer*.

Bosque County is complaining of grasshoppers; the warm weather having brought out the pests by the million.—[*Prairie Farmer*, March 31, 1877.

Mr. J. H. Beneke, just returned to San Antonio from New Mexico, first saw locusts at Fredericksburg, about seventy-three miles west of San Antonio. They are about half-grown there now.—[Note by Mr. Riley, April 5, 1877.

Caloptenus spretus here in countless myriads. Commenced traveling north.—[J. H. Myers, Salado, Bell County, April 7, 1877.

The young 'hoppers have taken up their line of march; course northwest. They are about one-half to three-fourths of an inch in length. The first lot that hatched have gone in the above direction for several miles to get into timber, brush, or sheltered places. They have not done much damage yet. In general opinion their wings will

be large enough in another month for them to commence their flight out of the country to their homes north.—[John H. Secrist, Austin, April 9, 1877.

Advices from Texas say that around San Antonio and Dallas the 'hoppers are swarming and eating up everything eatable. Great destitution is reported in portions of Eastern Texas, some families being upon the verge of starvation. Large numbers of unemployed men with families, who have been thrown out of work in consequence of this locust raid, are now on their way to Saint Louis.—[*Western Farm Journal*, April 12, 1877.

Dr. Coleman has probably informed you that grasshoppers, to the number of probably five hundred, settled on his premises on May 1; but he may not have told you that at my boarding-place, a hundred yards farther west, none alighted, at least none were observed.—[J. T. Moulton, jr., Calvert, April 12, 1877.

[Correspondence of Saint Louis Globe-Democrat.]

PARIS, *April* 14.—Wheat and corn are doing well. There are no grasshoppers in this section.

HEMPSTEAD, *April* 15.—We are free from grasshoppers in our county, or rather they are so few that we have sustained little or no damage from their presence. Between the birds, rains, and strong southeast winds, we hope to get rid of them entirely.

WACO, *April* 16.—Grasshoppers are here in considerable number, and have destroyed many oatfields and some wheat. The growing wheat looks well.

ENNIS, *April* 16.—There are numerous grasshoppers in this section, and great fears are entertained that the grain crops will be seriously injured.

HOUSTON, *April* 16.—Crops in the lower portion of the State are doing splendidly. Grasshoppers have not done much damage within a circuit of about eighty-five miles from Houston; last week they were reported to have done a good deal of damage near Austin; since then they are reported to be moving westward.

JACKSONVILLE, *April* 16.—The crop is yet too young to make any report, although the present prospects are quite promising; there is no or very little wheat planted in East Texas, all grown in West Texas; the grasshoppers are very bad in that section; none in this.

JEWETT, *April* 16.—We have plenty of grasshoppers out; they seem to be harmless. Grain crops are doing well.

LITCHFIELD, *April* 16.—Since the warm spell we had in February repeated experiments have been made to hatch out the grasshoppers, and in almost every case has been a failure, as most of the eggs seem to be decayed or dried up. Before the warm spell they would hatch out by keeping them in the house near the stove. The farmers are busy putting in their grain, and feel confident of a good crop. The ground was never in better condition than it is at present.

[Correspondence of the Saint Louis Times.]

PLANO, COLLIN COUNTY, *April* 16.—The grasshopper question is now being fully discussed all over our section. The 'hoppers commenced hatching about six weeks ago, and still continue to do so. The weather has been very favorable for planters, and more so for the grasshoppers. The estimate as to the damage done by the latter up to this time is one-third of the oats and wheat and nine-tenths of the gardens. They seem to do more damage on farms which are situated on rolling lands joining small creeks and the timber. Some farmers say there is a great deal of the early wheat now heading out, and the 'hoppers climb up the stalk during the night and eat off the head. So if this be the case all the early wheat will be destroyed. Our hope then will be for the 'hoppers to leave in order to leave us the late wheat, but the trouble is they cannot easily get away. Very few of them can fly, and young ones are still hatching out, so I see no hope of any wheat and oats to be left, except in fields which they do not get into.

I had the finest prospect of a garden in the town, consisting of peas, beans, lettuce, radishes, and numerous other vegetables and plants, which are all eaten up. It looks as if there never was anything planted there. The onions were six inches high when I first discovered the 'hoppers, and in one day and night everything was eaten to the ground, and nothing has come out since. My impression is that the insects poison the roots. There are large farms in our section of wheat and oats which are all eaten up; not a spear to be seen. They look as if nothing had ever been planted there. The cotton will be up by the 15th of May, as most farmers will not plant until late, thinking the 'hoppers would leave, but I have no reason to think they will, so I look for the cotton to be damaged to a certain extent.

The 'hoppers now are taking to the fruit-trees and eating off all the leaves and the small peaches, and, generally speaking, taking everything as they go.

Business is at a stand; nothing doing. One clerk could attend to the whole town nowadays so far as trade and traffic are concerned.

H. C. OVERAKER.

[Correspondence of Saint Louis Globe-Democrat.]

KOSSE, *April* 17.—Crop prospects are poor, the grasshoppers doing great damage to growing grain. On some farms every vestige of vegetation has disappeared.

CORSICANA, *April* 17.—The writer is just in from an eight days' drive embracing the three counties of Ellis, Hill, and Navarro, and finds but small amount of damage done by grasshoppers. Stands of corn and oats are damaged in small spots about the edge of the timber. In the aggregate the damage is small, and soon expect them to leave.

MCKINNEY, *April* 17.—The prospect for wheat and corn is bad, the grasshoppers doing much damage and no sign of their leaving.

CROCKETT, *April* 17.—Cotton-planting delayed owing to excessive rains; about half planted. What has been planted is well up and doing finely. No grasshoppers yet. Prospects good.

BRYAN, *April* 18.—Grasshoppers are very numerous, destroying gardens whenever a swarm strikes them. They have in some instances destroyed young crops. They are hatching out in different litters. As they get large enough to travel they go north.

LULING, *April* 18.—There are no grasshoppers in this part of the State, and crops are doing well.

TEXAS LOCUSTS.—I came to Ellis County in 1859, and have lived in Northern, Middle, Southern, and Southwestern Texas since then, eighteen years, and have never seen any serious damage from grasshoppers. The pests have invaded portions of the State several times, and in fact came as far south as Washington County last fall, and have been hatching out for several weeks, but they disappear as fast as hatched, from birds and other causes, and the farmers here do not apprehend any damage unless to a few early-planted gardens. The climate seems unfavorable to them; and besides they would hatch and be grown and fly northward before crops would be up. They have been known to do some little damage occasionally in a small portion of Northwest Texas only. The usual time of coming is October or November, and then they could do no damage to this section.—[R. E. C., Washington County, Texas, in *New York Tribune*, April 18, 1877.

[From the Globe-Democrat.]

CALVERT, *April* 20.—We have had the grasshoppers with us for the last two months in large numbers. They have done a great deal of damage to corn, oats, small grain, and gardens, but so far have done little injury to cotton. The young ones seem to do the most damage. Farmers believe they will leave in two weeks, and if this occurs the prospect will be good.

LULING, *April* 20.—Grasshoppers have done little damage, and have commenced flying north.

SAN ANTONIO, *April* 20.—Crops never looked better, and there are no fears of serious damage by grasshoppers.

We are having very heavy rains every few days, principally during the night, accompanied with incessant discharges of electricity and generally commencing or closing with a great deal of small hail. I think a great many of the insects are destroyed by these rains. They appear, however, to be very good barometers, and always seek places of safety some hours before the rain commences, and they invariably get on the sheltered side of the object to which they cling.—[Letter from W. L. Coleman, Calvert, Texas, April 24.

[Correspondence of the Globe-Democrat.]

HEARNE, *April* 25.—So many contradictory stories are told in reference to the grasshoppers in Texas, and the damage they are doing, and what they are not doing, that I thought I would make my statement. I came into the State of Texas at Texarkana on the 22d of February, and since that time until now have been traveling by rail, stage, and privaet conveyance, and have been at all of the large and medium sized towns in Eastern, Southern, Western, and Central Texas, and as far north as Waco, McLennan County. I have taken great pains to inquire of farmers in each place visited, and by my own personal observation by going into the fields and examining for myself the operations of the Texas grasshoppers, and to ascertain the amount of damage they are doing and its probable results. I find there are more or less grasshoppers in nearly every portion and county of Texas visited, and that they are doing more or less damage in places where they are; but, unlike their operations in Dakota, Nebraska, and Kansas, where I have seen them at their worst, sweeping as they go, in Texas the damage is not general but local; for instance, in a neighborhood they will eat up four or five acres of cotton for one farmer, and not do any more damage in that vicinity, or for five or six miles around. What is peculiar about their operations here in Texas is that they then leave, doing no more harm in that locality, but pounce down in some other place, miles away, destroying nothing intermediate, and invariably moving north. The most damage I have witnessed is in the neighborhood of Bryan, in Brazos County. A well-informed farmer here estimates that the amount of damage to the entire crop of the county will be about one per cent. in Brazos County, and there will be a large per cent.

of the damage done to the entire State as far north as Bryan and Waco. In the mean time there is a complete scare, and dealers will buy only by piecemeal. Trade in the county seems to be at a stand-still, and if a commercial traveler attempts to sell a bill of goods the dealer says "grasshopper!" I am now going into Northern Texas, and more about the grasshoppers anon. A. B. S.

NEW BRAUNFELS, *April* 25.—We have had a fine season so far, and oats, which have been but little disturbed by the grasshoppers, promise seventy-five bushels to the acre. We may say that two-thirds of the wheat crop are gone. Grasshoppers moving northward, and no further damage anticipated from them.

DALLAS, *April* 25.—Never before have the crops in North Texas looked better, though grasshoppers have begun to make sad havoc in wheat and oats, and fears are entertained that they will eat up the young cotton and corn. It is predicted that the pest will have disappeared in two weeks, and, if the prediction be correct, we will still have good crops.

CORPUS CHRISTI, *April* 25.—The grasshoppers have done no injury in the large district of country between the Nueces River in this State and the Rio Grande on the Mexican border. They have never done any damage in this section at any time. Crops are looking well.

PLANO, *April* 25.—Grasshoppers are still here by the million, have already destroyed many farms, and are now eating the wheat as it comes out. Many farmers are totally ruined. If the pest does not leave soon the cotton crop will also go up. Business is dull and the people are blue.

SHERMAN, *April* 30.—Aside from grasshopper ravages, crops—wheat, corn, and cotton—are looking well. Season rather wet, but not to an extent to interfere with the cultivation of corn. We have the promise of a good harvest. This will commence in about three weeks. In some sections 'hoppers have done considerable damage, but crops are so far advanced that the pests cannot seriously damage them.—[*Prairie Farmer.*

A strong wind from due south, and the air, as far up as the eye can reach, is filled with locusts moving north. Such of our local crop as can fly are rising. We have many late ones, too young to start yet.—[Letter from W. C. Walsh, Austin, May 1, 1877.

LEAVING THE STATE.—The Herald has strenuously maintained all the time that no serious damage would be done to the general crops by the grasshoppers, and that as soon as their wings were developed they would leave the country. Both these assertions have proven correct. Reports from all over the State show that the wheat crop never looked better. Damage has been done in certain localities, but the damage was only in spots, and cannot be counted in the general average. All danger is over now, for the grasshoppers for the last two days have been winging their way northward, millions upon millions of them. They can only be seen by looking very closely at the sky, and as near the sun as possible. Many of our citizens were busy yesterday gazing at them through glass and spectacles. Parties in other States need not fear to come to Texas on account of grasshoppers.—[*Dallas Herald,* May 3, 1877.

DEAR SIRS: The present season has been one of many doubts and fears, owing to the appearance of the grasshoppers; and while they have done some harm, it has been mostly confined to gardens, with a slight damage in some cases to wheat and oats. This latter, however, was only in places, and not by any means general. Taking into consideration the increased acreage, I am prepared to say that our yield of cereals in this section will be fully up to last season, if not more; provided nothing happens in the mean time to cut our crops short, and as our farmers will commence harvesting in fifteen days, all seems favorable.

In the sections of this and surrounding counties where damage has been done by the grasshoppers, the farmers lost no time in preparing to resow, and the consequence is that, with very few exceptions, the crops thus destroyed have been replaced by cotton, corn, millet, and Hungarian seed, all of which promise large yields.

The present growing crop of cotton is larger than that planted last year and bids fair to make a larger yield; but, as a general thing, more attention is being paid to grain, caused by the anticipated decline in cotton and promised increase in value of breadstuffs, the result of the Eastern troubles.

Any inquiry regarding the crops I will be at all times ready to answer cheerfully, as well as any other information desired.—[Letter from T. C. Haggart, Dallas, May 15.

The pestiferous 'hoppers are departing from this section—going to Iowa, I suppose, to grow up with the country. The damage done during their sojourn with us is but slight. Wheat harvest has begun, and it is thought the yield of this county will surpass that of any previous year.—[Ellis County, May 26, 1877, *Colman's Rural World.*

The grasshoppers have nearly all disappeared from Texas, and the indications are that the State will have an abundant wheat crop this year.—[May 26, 1877, *Prairie Farmer.*

The grasshoppers that hatched in this section of the country and south have all left, going northwest. They did some damage to wheat, oats, and corn in fields that happened to be in their course; but on the whole the country has not suffered very much. The damage was done by the young, unfledged locusts. Gardens were more particularly injured.—[Letter from John H. Secrist, Austin, May 28, 1877.

A gentleman, writing from Paso del Oso ranch, San Antonio, furnished Professor Boll with the following data, with the understanding that his name should not be published:

1876. *Saturday, 21st October.*—Thermometer ranged since 2d between 68° and 90°. Winds generally southeast; but at times pretty cool north winds, with light rains. Grasshoppers arrived at sundown to-day. A noise like that made by bees swarming on trees preceded their appearance about ten minutes; the wind commenced blowing hard from the north—cold—bringing the grasshopper along like an immense dark curtain moving toward us, and about 60 or maybe 80 feet high.

Monday, 23d.—Grasshoppers finishing our four acres of beans, devouring mesquit leaves and many weeds.

4 p. m.—No decrease in grasshoppers: in our beds, on our pillows, and all round us last night. Heavy dew last night; might be called a frost.

Monday, 6th November.—Heavy rain Saturday night; night dark; norther with cold wind. Grasshoppers left last night, but flies continue—real hard-biting fellows.

The grasshoppers at this place, nine miles below San Antonio, laid their eggs in hard ground on well-beaten roads, or on either side, showing no particular taste for a cushioned bed. At the mission Espada, 1½ miles above me—irrigable—they laid their eggs alongside of the ditches. Those that were laid in the field, if they were disturbed about time to move by plowing, jumped to the brush and grass along the ditches, coming from their cover to devour our tomato and red pepper (three times); also, when our melons and peas were large enough, they finished most of them, and a good deal of our early corn, but left our oats untouched.

About three weeks ago a large swarm (about three hours passing) passed over us, and about a week ago another. They acted very differently when they came last fall, for they came then like an immense curtain, drawn along the ground from east to west; but these went high and north.

If the above extract from my ranch memorandum should prove of the least value in aiding in the discovery of some means to destroy this infernal pest, I shall consider myself well paid for what attention I gave the matter.

No traps or other means of getting clear of the grasshoppers have been tried here.

I forgot to say Paso del Oso is 9 miles in a straight line and 12 miles by the road and on the right bank of San Antonio River, below San Antonio.

In 1875, the 'hoppers commenced arriving about eleven o'clock in the morning and about twenty times as numerous as we sometimes see the common fishing 'hopper. At that time they kept outside of the lowland fields, keeping outside of the fences; but the following spring they seemed perfectly at home in the river fields, where they destroyed nearly all of fifty acres of my corn, which I had to replant.

Texas farmers are beginning to believe that the grasshoppers were a deeply disguised blessing. It is said that the most pestilential weeds have been eradicated, root and branch, by the locusts.—[Colorado Farmer, June 7, 1877.

The 'hoppers have all left here now. No one seems to know which way they went. I think they went northwest, as the wind was for many days blowing from south, and of course they went with it.—[Letter from H. C. Overaker, Plano, June 8, 1877.

As you desire information about the locusts from all parts of the country and supposing that you may not have any as far southwest as Victoria County, Texas, I quote to you the following from a letter of June 12, just received from G. Onderdonk, an eminent and trustworthy fruit-grower at Mission Valley:

"The locusts have done me considerable damage; they killed a large share of my cuttings (grape); also by eating out the pear buds set in my quince stocks last October. They killed arbor-vitæ trees six feet high so completely that they are past recovery. Yet the farming interest is not seriously affected. Wheat, oats, &c., are harvested in good order; excellent yield. Corn is now in roasting ears, and will be heavy. Irish potatoes gathered twenty days ago, very fine. The locusts have not hurt my orchards nor my vineyards. They have depredated 'in spots.'"—[Letter from Isidor Bush, Saint Louis, June 20, 1877.

The southern limit of the extension of the grasshoppers in Texas seems to be San Antonio and Houston, the latter place also including their eastern limit, as they never go beyond that point. Farmers residing near Cypress City, some twenty-five miles north of Houston, who have been living in the vicinity for over a quarter of a century, assure me that they had no grasshoppers either last autumn or this spring.

The investigations of this question for Texas are not yet accomplished, and this brief report refers only to inquiries made in the southern portion of the State.

The damage, generally speaking, is not important. The destruction last fall was

limited almost entirely to gardens. The young grasshoppers which came from the eggs this spring appeared only here and there, many early fields suffering but little, and in a number of instances entirely escaping.

Wheat is not raised to any great extent in San Antonio or New Braunfels, and only in the higher situated regions of Gillespie and Blanco Counties was the destruction of the wheat crop an item of considerable importance. Oats were damaged but little by the grasshoppers, and the cotton was unplanted until after they had disappeared. They all left the southern section of the State before the 1st of May, and by the 12th of June I saw corn silk and tasseling in the productive valleys of Guadalupe, Colorado, and Brazos, and in many places the cotton began to develop its blooms. In general the impression made on my mind by the appearance of the cultivated lands was the same as if the grasshoppers had never been here. Some miles northeast of Austin I saw on the 18th of May, oats, corn, trees, &c., very much damaged, but the damage was not done by the grasshoppers, but by a hail-storm. Yet everywhere I was assured that for twenty years the grasshoppers had never come in such enormous quantities.

Although the investigations for Texas have not yet been finished, I will draw some inferences from personal observations made hitherto. Professor Riley says that in Texas they (the grasshoppers) will never be of a dangerous nature. I find this declaration completely corroborated by the result of the wheat crop of those counties in which the grasshoppers were the most numerous.

It is wheat that suffers most from the ravages of the grasshopper, yet, nevertheless, we have a good average crop of about fifteen bushels per acre.

* * * * * * *

Another observation for our country is the following: The whole prairie of Northern Texas was covered last fall with a very troublesome plant called broomweed. This spring the propagation of this plant was stopped by the destruction of the young buds by the grasshoppers. This weed will now almost entirely disappear for some years, and our prairies will be covered with a much better grass. Thus, even a calamity, under certain circumstances, can be rendered advantageous to a certain point, as, for instance, it is a well established fact that after heavy storms malignant epidemics suddenly disappear.

But from what is above stated, we must not conclude that the grasshopper question should be neglected or even treated indifferently. I shall have more to say upon this important subject when my investigations shall have been concluded.—[Letter from J. Boll, to the Dallas *Mail*, June 19, 1877.

The area invaded by the grasshoppers in Texas, in the fall of 1876 was embraced between the longitudinal parallels of 93° and 99° west from Greenwich, or 19° and 22° west from Washington, and extending entirely across the State from Red River on the north to the Gulf of Mexico on the south, crossing and covering six degrees of latitude; or covering an area of about 200 miles in width by 360 in width, or 72,000 square miles. This belt extends through the center of the State from north to south between parallel lines, with somewhat irregular edges, varied only by the course of the wind at different times during their "march to the sea." By reference to the map of Texas it will be seen that the best agricultural portion of the State was covered by them.

The precise state of arrival I am unable to give, but they crossed Red River about the last of August and continued their movement southward for between six weeks and two months.

Their flight was due south except as varied by the winds from the west or northwest; but the prevailing wind was from the north.

The area covered by the eggs was the same as that over which they made their flight, as is fully attested by the myriads of young 'hoppers that have been making their appearance since the 1st of February.

The damage done by them last fall was comparatively small in consequence of their late appearance. All crops were matured and gathered except cotton and sweet potatoes, which were well advanced. The grass was mostly dry from the drought in the latter part of summer. Their number was legion, and for several days during their passage across the railroads trains were delayed for hours, and often stopped by them. Col. L. J. Dupré, editor of the *Austin Statesman*, writes me: "I only saw the sun as through a glass darkly for ten days, when the living clouds swept southward from Pike's Peak to the sea. It was a smoked glass that covered immensity and the sun's disk. The mountains and plains about Austin are covered with the measureless swarms of locusts."

From information before me from thirty counties included in the area covered by deposits of eggs last fall, that these pests are appearing in immense numbers all over the section named, threatening destruction to all early vegetation, both of garden and farm; large portions of the country being literally covered with them, from the size and appearance of a flea upward. It is hoped their early appearance indicates an early departure, and the hope is entertained that corn, cotton, and all the later crops may escape. In Northern Texas, where they have just had snow and a freeze, they hope to

be rid of all that had hatched; while there is no such hope for the people of Southern Texas, much faith is placed in the birds, prairie chickens, and heavy rains; the latter we have just had. The *Gonzales Enquirer* says: "Reports from this and adjoining counties state that the grasshoppers are hatching out by the millions. The birds are having a good time feasting upon them, but nothing but a general rain—a regular trash-mover—will save the crops." Farming operations are active regardless of the grasshoppers, as many farmers believe they will die of starvation or emigrate before the crops are large enough to furnish them food. Notwithstanding all this, the gravest apprehensions are entertained as to the future, with almost a certainty of no vegetables, and possibly no fruit or crops of any other kind. They are destroying everything green.

The *Bastrop Advertiser* says: "The late rains destroyed great numbers of young grasshoppers, but there are at least a million to the square foot left, alive, kicking and jumping, and preparing to devour everything within their reach. If the clerk of the weather would only turn on the water and give us a perfect deluge, a Noah's flood in a small way, we might hope to be rid of these pestiferous crop-destroyers."

The next issue of the paper corrected the above statement as to the number left, by saying: *There are immense quantities*, and it is feared much damage will be done the coming crop.

In Collin County, on the northern boundary of the State, grasshoppers in countless numbers are being hatched out, and signs of their ravages are plainly visible on early vegetation.

The *Belton Journal*, speaking of the innumerable multitudes of 'hoppers that have hatched, says: "In past years they have been considerate enough to leave as soon as they could fly, and we trust they may pursue the same course this season."

Judge Buford, an old planter near Dallas, who has been a close observer of the 'hoppers from their first visit to Texas, gives it as his opinion that as soon as they are large enough to fly they will take their departure, and no danger to crops in this State will ensue.

It appears that our 'hoppers came from the northwest last fall, spreading from Red River to the Gulf. At the approach of winter they began to bore into the earth and deposit their eggs. The very mild winters in this section enable the eggs to hatch upon the appearance of the first warm days of spring.

The county officials of Caldwell County have kept in their county records a diary of the grasshopper in that county since their first appearance in 1847; and the same facts are applicable to all the section visited by them. I am indebted to S. J. P. McDowell, esq., clerk of the court of that county, for the following grasshopper statistics of Caldwell County:

"Made their appearance in this county October 1, 1847; remained during the fall, with but little damage.

"November 6, 1857, made their appearance—came from the west; after destroying turnips, &c., in the fall, and growing crops in the spring, commenced disappearing about 20th April, 1858.

"October 14, 1867, made their appearance—came from the north; but little damage.

"October 7, 1876, made their appearance from the north in a slight norther, and remained until December 1, 1876. In all portions of the county commenced hatching last of January (in sandy regions earlier than other portions) and yet hatching [March 6, 1877]. Their flight in the fall toward the south generally in a north wind. Regularly, at about noon, they seemed to collect in large swarms, rise, and proceed on their journey."

For forty years they have made their appearance regularly at an average interval of ten years each.—[A. B. Small, Houston, March 16, 1877.

[The following reports have been kindly collated by Sergeant C. A. Smith, United States signal observer at Galveston. They appeared in the *Galveston Daily News* of the dates indicated, this paper having regularly quoted the locust news from its exchanges in other parts of the State.]

Freestone County, January 20.—The old field larks are said to be destroying large quantities of grasshopper eggs deposited in the ground in this vicinity last fall.

Bexar County, January 9.—Field larks and other small birds are spending most of their time scratching the ground in pursuit of grasshopper eggs.

Caldwell County, January 31.—The cold weather has had no effect on the deposit of grasshoppers. The little ones hatched out and hopped about as lively in the sleet as though they liked it.

Colorado County, February 4.—The last few days of warm weather has hatched great numbers of young grasshoppers.

Burnet County, February 6.—Farmers are planting, notwithstanding the prospect of grasshoppers.

Gonzales County, February 8.—The young grasshoppers have made their appearance.

Austin County, February 10.—There is a great deal of talk of grasshoppers; some anticipate the destruction of the coming crop by them.

Travis County, February 10.—A farmer who lives east of the city says the young grasshoppers are hatching out in considerable numbers in post-oak regions. Specimens of dirt were brought to the city by Captain Walsh containing vast numbers of the eggs.

Austin County, February 14.—The "Banner" says grasshoppers are appearing in countless millions.

Colorado County, February 14.—The hatching process is still going forward with the "grasshoppaire."

McKinney County, February 14.—Grasshoppers are being hatched out by the warm weather of the past few days.

Robertson County.—The whole face of the earth is literally full of grasshopper eggs, and the recent severe weather has had no effect on them. They have commenced hatching within the past week, and the young may now be seen in every direction.

Bastrop County, February 15.—Grasshoppers are hatching out by millions. In sandy land they can be seen as thick as fleas in a hog-bed.

Gonzales County, February 15.—Reports from this and adjoining counties state that grasshoppers are hatching out by millions. The birds are having a good time feasting on them, but nothing but a general rain will save the crops.

Washington County, Brenham, February 20.—Grasshoppers are hatching out.

Laraca County, February 22.—The grasshoppers are hatching out all over our county, in some places the ground being literally covered with them.

Jackson County, Morales, February 23 —Grasshoppers' eggs are plentiful here, and much fear is entertained as to their reappearance soon.

Colorado County, February 23.—Planters inform us that the late cold weather and rain destroyed millions of young grasshoppers. They are hatching out, though, as before the cold weather.

Caldwell County, February 23.—On light sandy land the young grasshoppers are coming out by millions.

Guadalupe County, February 23.—Since the rain there has been a large quantity of grasshoppers hatched out. The rain destroyed most of them that were already hatched.

Laraca County, February 23.—Grasshoppers are reported to be injuring gardens in some localities in our county.

Bell County, February 28.—Grasshoppers are hatching out in this section, but it is hoped they will leave before they get large enough to do material damage.

Bastrop County, February 28.—Late rains destroyed great numbers of young grasshoppers, but there are at least a million to the square foot left alive, kicking and jumping.

Hays County, February 28.—Myriads of young grasshoppers. It is feared they may survive their infancy and cause trouble.

Dallas County, March 1.—Grasshoppers in the country threaten to eat out the substance of the people.

Victoria County, March 1.—In warm, sheltered localities the grasshoppers are hatching out in considerable quantities. During the last ten days each succeeding day has added largely to their numbers. The farmers are confident that when strong enough they will take wing and leave.

Goliad County, Goliad, February 24.—Grasshoppers are reported plentiful in the vicinity of this place.

Gonzales County, Gonzales, March 3.—The last descending showers have killed off a great many young grasshoppers.

Grimes County, March 4.—We learn that thousands of young grasshoppers are being hatched out in sandy places in southwest portion of our county.

Collin County, March 6.—Grasshoppers in countless numbers are being hatched out, and signs of their ravages are plainly visible on early vegetation.

De Witt County, March 6.—The grasshoppers have made their appearance all over the county. Hatching out in myriads.

Falls County, March 6.—Grasshoppers are hatching out rapidly, but farmers apprehend little or no danger from them.

Lampasas County, March 6.—Myriads of grasshoppers are to be seen all over the county. They are beginning work on tender vegetables.

Robertson County, March 6.—Grasshoppers are hatching out by the million.

Washington County, March 6.—Grasshoppers continue to multiply on the farms near this city.

Bell County, March 7.—Innumerable multitudes of grasshoppers have hatched out all over this county, and it is feared they will injure crops.

Bastrop County, March 7.—The heavy rain on Wednesday night drowned millions of grasshoppers in the lowlands, but there are quadrillions to the square foot left, and it is feared much damage will be done to the coming crops.

Comanche County, March 7.—Millions of grasshoppers are now to be seen in some localities.

De Witt County, March 7.—Grasshoppers are abundant here and in adjoining counties, and it is feared they will destroy spring crops.

Gonzales County, March 7.—The young grasshoppers have already destroyed several gardens in town.

Live Oak County, March 7.—Young grasshoppers are quite numerous in places, and our fine gardens are thought to be in a critical condition.

Fayette County, March 9.—Young grasshoppers are quite numerous in this section.

Goliad County, March 9.—The small grasshoppers are showing themselves in the fields and gardens about Goliad.

Johnson County, March 9.—Young grasshoppers are making their appearance in great numbers in some portions of the county.

Bosque County, March 10.—Grasshoppers are overrunning the northern portion of this county.

Colorado County, March 10.—Myriads of grasshoppers everywhere. Birds are destroying them, but they are too thick for them to get all.

Fayette County, March 10.—Young grasshoppers are at work devastating tender vegetation.

Hill County, March 10.—The grasshoppers have hatched out and the ground in many places is covered with them.

Hays County, March 12.—There is some complaint of damage to gardens by grasshoppers, though farmers are planting and seem not to fear their ravages.

Bastrop County, McDade, March 12.—Young grasshoppers are on the rampage, and farmers are looking blue.

Anderson County, March 13.—Young grasshoppers by the million are now making their appearance all over the county.

Caldwell County, March 13.—We learn that large numbers of grasshoppers are dying and others are traveling northward. As yet but little damage has been done.

Goliad County, March 13.—Young grasshoppers are making their appearance, and our farmers wear queer countenances in consequence.

Lampasas County, March 13.—The rains did not drown the grasshoppers. Thousands of them are infesting the county and beginning to destroy vegetation.

Milam County, March 13.—It is reported that the young grasshoppers are going north already.

McLennan County, March 13.—The grasshoppers survived the rain and hail of Wednesday night, and skipped about yesterday in undiminished numbers. As yet they have done but little damage to vegetation, and it is hoped they will soon take wings.

Lampasas County, March 13.—The rains did not drown the grasshoppers. Thousands of them are infesting the county, and are destroying whatever they can find tender enough for their use.

San Saba County, March 13.—Young grasshoppers are reported in numberless quantities in the western portion of the county.

Bastrop County, March 14.—A heavy rain visited this section last Wednesday night accompanied by high wind, but we have not heard of the grasshoppers being much damaged thereby.

Wilson County, March 14.—The grasshoppers have diminished considerably in numbers since the last rain.

Erath County, March 15.—The grasshopper eggs deposited in the ground last fall are being hatched out, and the young 'hoppers are making their appearance in great numbers in different parts of the county.

Freestone County, March 15.—Young grasshoppers are making their appearance by the million in nearly every part of the county.

Hays County, March 15.—Farmers are hopeful that the grasshoppers will depart without doing much damage.

Johnson County, March 15.—Young grasshoppers are making their appearance by the million.

Live Oak County, March 15.—Young grasshoppers are quite numerous.

Hill County, March 16.—No harm done as yet by the grasshoppers, and they are not as numerous as they were a week ago.

Colorado County, March 16.—After the rain of Monday last millions of fresh grasshoppers appeared. Field larks and blackbirds are still putting in good work.

Fayette County, March 17.—The young grasshoppers are westward bound, and are consuming all description of vegetation on the way. We learn from reliable sources that the first and second hatchings have disappeared and that in many localities little fear is felt.

Lavaca County, March 17.—Grasshoppers are very numerous throughout the county, devouring garden vegetables, &c.

Caldwell County, March 18.—The grasshoppers are still here.

Grimes County, March 18.—Occasionally we hear of the appearance about town of young grasshoppers, but they are few.

Lee County, March 18.—The grasshoppers are still here.

Washington County, Brenham, March 19.—Grasshoppers are destroying gardens as fast as they advance.

Travis County, Elgin, March 19.—Grasshoppers are consuming corn, wheat, and oats, and are making great havoc in gardens. Farmers are looking somewhat despondent.

Bell County, March 20.—We learn that the grasshoppers are less numerous than they were a week or ten days ago, and it is now believed they will do but little damage.

DeWitt County, March 20.—We learn from Mr. J. R. Hamilton, planter on Deer Creek, that the grasshoppers are disappearing from his neighborhood.

Falls County, March 20.—Little grasshoppers are increasing by countless millions.

Limestone County, March 20.—Myriads of little grasshoppers are to be seen on our prairies and in our fields.

Milam County, March 20.—The woods are fairly alive with young grasshoppers. They are not all hatched out yet, and none are able to fly. Gardens are past saving and wheat is gone wherever they touch it. One encouraging feature is that as soon as they hatch out they commence jumping northward. This seems to indicate that they will leave as soon as their wings put out, as they did in 1868.

Victoria County, March 20.—The grasshoppers are said to be leaving as soon as hatched.

Grayson County, Denison, March 20.—Grasshoppers are numerous, but not alarmingly so.

Bastrop County, March 21.—Grasshoppers are out in swarms, but no particular damage is reported as yet.

Grayson County, March 21.—Young grasshoppers are now quite numerous.

Guadalupe County, March 21.—The young grasshoppers have already devoured several small fields of wheat and oats. It is feared they will greatly damage these crops, which are large in this county.

Gonzales County, March 21.—Mr. L. B. Green, residing on the river, reports the prairies and valleys literally covered with grasshoppers, and that they appear to be drifting in waves, and at night take to the broom-weed, and feast upon the dead wood of the same. The largest are about one-third grown, and range from that down to the size of a flea. On the opposite side of the river, at John Steen's, there are none.

Washington County, March 21.—Some complaints are made of the ravages of grasshoppers, which are not serious as yet.

Washington County, Brenham, March 21.—Old farmers are confident that the corn eaten off by the grasshoppers will come out all right yet, as the roots are healthy.

Washington County, Chapel Hill, March 24.—No appearance of damage from grasshoppers.

De Witt County, March 27.—Grasshoppers are doing immense damage in the neighborhood of Cuero. They appear to be hopping northward, not yet having wings.

Guadalupe County March 27.—In some places the grasshoppers have attacked young peaches, and have nearly destroyed some crops of oats and wheat. As they grow their ravages increase.

Lampasas County, March 27.—In many places the grasshoppers are doing but little damage and the people are going on with their work without fear of injury, while in other localities tender vegetation is being trimmed off even with the ground.

Live Oak County, March 27.—Grass in this section is starting up finely and considerable farming is being done, although grasshopper depredations are much feared.

McLennan County, March 27.—The grasshoppers existing here in myriads are destroying gardens and doing considerable damage to fruit-trees. They have not damaged the grain-fields as yet, and as they are growing rapidly and moving northward it is hoped the grain will escape.

Milam County, March 27.—It is said that the grasshoppers have seriously injured the wheat in Milam County. In some places they have completely stripped the ground of vegetation and are now leaving the county, going north.

Navarro County, March 27.—The grasshoppers are going for the wheat.

Waller County, March 27.—Grasshoppers about the size of house-flies have made their appearance by millions, and grave apprehensions are entertained that they will eat up the growing crop.

Washington County, March 27.—Judge Bowers reports that in the neighborhood of Burton the grasshoppers have eaten the corn off even with the roots.

De Witt County, March 28.—Grasshoppers have taken possession of the country in this vicinity. Gardens, fields, the forests, and prairies are covered with them.

Leon County, March 28.—The grasshoppers in this county are eating down the young corn and are doing great damage to the gardens and everything green.

Laraca County, March 28.—Grasshoppers are taking possession of gardens, and farmers are delaying planting.

Mason County, March 28.—In spite of the grasshoppers, some of the farmers have planted at least a portion of their crops.

Coryell County, March 30.—The little grasshoppers are still numerous, and their appetite is as destructive as ever.

Bosque County, March 30.—The grasshoppers threaten the total destruction of the wheat and oat crops.

Dallas County, March 30.—The shrubbery in the city is all covered with white covers to protect it from the hoards of grasshoppers.

Johnson County, March 30.—The little grasshoppers are still hopping in myriads. They have begun on the wheat.

San Saba County, April 1.—Grasshoppers are destroying wheat on Richmond Creek.

Tarrant County, April 1.—Fort Worth, March 31: Grasshoppers are plentiful and doing some damage.

Robertson County, April 1.—Hearne, March 31: Grasshoppers are numerous, and have eaten up everything in shape of gardens.

Washington County, Chapel Hill, March 31.—Grasshoppers are eating all green vegetation to the ground.

De Witt County, April 3.—Grasshoppers are numerous and troublesome, eating out fields, and stripping plants and shrubbery in the gardens.

Gonzales County, April 5.—Grasshoppers have commenced on the corn in some portions of the county. They appear to be traveling in a northward direction.

Johnson County, April 5.—Grasshoppers are doing much damage in the county. It is thought one-half the wheat in the timber has been destroyed. Oats have been eaten down to the ground, but will come out again if the 'hoppers leave. Corn is eaten as much by day as it grows by night. Gardens thus far have stood no show.

Laraca County, April 5.—Complaints of injury from grasshoppers are coming in on all sides.

Washington County, April 5.—On the plantation of Mr. Thomas Smith, near Chapel Hill, the grasshoppers have eaten out about thirty acres of corn.

Waller County, April 5.—Grasshoppers are injuring the crops considerably.

Bexar County, April 7.—Grasshoppers are making serious inroads upon vegetation in the northern part of the county.

Washington County, Brenham, April 7.—In some portions of the county the grasshoppers have made a clean sweep. Especially is this the case in the neighborhood of Long Point and Gay Hill.

Colorado County, April 8.—Little damage has yet been done by the grasshoppers, their depredations being mostly confined to the tender vegetation of the gardens. What little they travel seems to be in a direction a little north of west. None of them we have seen have yet arrived at maturity, and of course are without wings.

Grayson County, April 8.—But little further damage from grasshoppers anticipated. Wheat is getting too tough for them, and they prefer the young grass on the prairies.

Mason County, April 8.—Corn is coming up, but the grasshoppers meet it at the surface of the ground.

McLennan County, April 8.—Oats are knee-high, and not a grasshopper within five miles.

Menard County, April 8.—The grasshoppers are not numerous up here.

Washington County, April 8.—Grasshoppers are here in myriads. In some localities they are destroying all green vegetation, while in others corn is growing finely.

Williamson County, April 8.—Grasshopper ravages are feared by farmers.

Bexar County, April 10.—Grasshoppers are plentiful in the neighborhood of Cibolo, but have done no serious damage as yet.

Brazos County, April 10.—Some apprehensions from grasshoppers.

Cooke County, April 10.—Grasshoppers are numerous in southwestern portion of this county, and in portions of Denton, Wise, and Montague that lie near us but as yet have done little mischief.

Comanche County, April 10.—Grasshoppers are diminishing in numbers in this county.

Collin County, April 8.—Several of our farmers say that their crops of wheat and oats have been ruined by the grasshoppers. A Mr. M. C. Smith informs us that they have eaten thirty acres for him, and that there is no possible chance for it to come out. They are beginning to penetrate the timber regions, which have hitherto been exempt from their ravages.

De Witt County, April 10.—Grasshoppers are disappearing in spots, and appear to be gathering in the bottom lands. Having devoured all the young vegetables, they have, in some localities, gone to work on the young corn.

Limestone County, April 10.—Grasshoppers have as yet done no material damage, and have only appeared in a few localities.

Gonzales County, April 11.—From every portion of the county we learn that grasshoppers have done but little damage as yet. They are growing in size, and few have wings. Some have commenced shedding, while a number of small ones have appeared, which indicates that they are still hatching.

Kimble County, April 11.—Grasshoppers are scarce.

Mason County, April 11.—Grasshoppers are still numerous, and are at work on corn and peaches.

Wilson County, April 11.—Grasshoppers thus far have done no damage.

Austin County, April 12.—Grasshoppers have not interfered with the crops.

Hamilton County, April 12.—In some locations grasshoppers have destroyed gardens, but altogether crop prospects are encouraging.

Limestone County, April 12.—The "Record" says grasshoppers have done but little damage.

Denton County, April 15.—Wheat-fields almost clear of grasshoppers. They are leaving the fields and taking to the woods.

De Witt County, April 15.—Grasshoppers not so numerous and getting wings. Still at work on young corn and what is left of gardens. Fruit-trees thus far not injured.

McLennan and Bosque Counties, April 15.—Grasshoppers numerous near the line separating the counties, but have done little or no damage.

Washington County, April 15.—Myriads of grasshoppers hopping about, but do not seem to be going in any particular direction. In some fields they have eaten the young crops entirely up, while others they have not touched.

Atascosa County, April 17.—Grasshoppers are in the county.

Brazos County, April 17.—Grasshoppers are not generally diffused over the county, but move in large families. In many places they have destroyed everything, while many have escaped untouched. Many of our citizens have saved their growing peaches by applying tar to the bodies of the trees, which prevents the 'hoppers ascending. Mr. James P. Wilson and family have waged relentless war against them, and have thus far prevented them from destroying anything. Liberal use was made of fire, boards, carbolic soap, tar, kerosene, and turpentine.

Colorado County, April 17.—Grasshopper depredations continue in places. The 'hoppers are growing fast, and it is thought will soon take wings. Some reports say they are already flying. As yet damage to crops is limited.

Comanche County, April 17.—The "Chief" announces that grasshoppers are disappearing in Comanche County.

Freestone County, April 17.—Grasshoppers still here. In some localities they have done considerable damage to small grains, fruits, and corn.

Fayette County, April 17.—Grasshoppers doing some damage, but not serious. They seem to be in spots.

Grayson County, April 17.—The pests are now attacking the blossoms on the fruit-trees, with a fair prospect of destroying the crop.

Kerr County, April 17.—Grasshoppers have done no material damage.

Navarro County, April 17.—Wheat has been damaged in a few places by the grasshoppers.

Robertson County, April 17.—The grasshoppers are going north as rapidly as their legs will carry them. They have no wings as yet.

Bexar County, San Antonio. April 16.—Grasshoppers are abundant.

Fannin County.—A few grasshoppers were visible up to April 19 and 20, but no damage.

Grayson County.—Grasshoppers numerous about March 20 and 24, and had destroyed several small fields.

Dallas County, April 7.—Grasshoppers are reported about March 20 as having injured fall-wheat and oats. They appear in small collections. Having generally selected hill-tops to deposit their eggs, have hatched out and remained there.

Hill County, April 13.—Corn in some neighborhoods has been swept clean by the grasshoppers.

McLennan County, April 13.—Grasshoppers numerous, but not doing much damage. The face of each individual 'hopper is turned northward.

Limestone County, April 13.—Grasshoppers are causing some delay in planting cotton.

Washington County, Chapel Hill, April 13.—Grasshoppers are doing but little damage except to gardens, which they have almost devastated. They are leaving the uplands and going to the bottoms.

Collin County.—Damage from grasshoppers not great, and will not materially affect crops.

Comanche County, April 18.—No grasshoppers to hurt much.

Guadalupe County, April 18.—A few isolated farms injured by grasshoppers.

Grayson County, April 18.—Grasshoppers doing but little damage to wheat. They confine their operations principally to oats.

Goliad County, April 18.—Grasshoppers doing but little damage to gardens or crops.

Hays County, April 18.—Grasshoppers still doing harm, but their number is believed to be decreasing.

Johnson County, April 18.—Grasshoppers still on hand. In some instances they have totally destroyed fields of wheat and oats, and the land had to be re-broke and planted in something else. Farmers are sowing millet in place of the oats eaten up.

Limestone County, April 18.—Grasshoppers are destroying a few gardens. They seem to be very much in spots. But few heard of in the black lands.

Madison County, April 18.—Grasshoppers doing no material damage.

Shackelford County, Fort Griffin, April 18.—No grasshoppers to be seen here.

Washington County, Brenham, April 17.—Grasshoppers not doing much harm hereabouts, though a few farmers have had to replant.

Guadalupe County, April 19.—Grasshoppers are playing sad havoc with wheat and corn fields in this vicinity, and farmers are mowing their small grain for hay.

Gonzales County, April 19.—Grasshoppers as yet are doing no damage in this section.

Henderson County, April 19.—Grasshoppers reported as doing some damage to corn crops in western portion of county.

Live Oak County, April 19.—Complaints of grasshoppers are coming in from every direction.

Williamson County, April 19.—Some farmers say the grasshoppers are destroying everything in their neighborhood, while others say that in their localities there are but few or none at all.

Brazos County, Millican, April 19.—Grasshoppers are not so numerous as heretofore, and have done but little damage to the crops. They have a special delight in gardens.

Bexar County, San Antonio, April 20.—Grasshoppers are here in abundance, but no harm has yet been done.

Limestone County, Groesbeck, April 20.—Grasshoppers by the million, but they are seen only in spots. No serious damage as yet.

Navarro County, Corsicana, April 20.—In some localities in the county the grasshoppers are playing havoc with the wheat-fields.

Travis County, Elgin, April 20.—Grasshoppers are plentiful.

Kaufman County, Forney, April 17.—Grasshoppers are not so numerous with us as with neighboring counties, probably on account of our land consisting of high, rolling prairie, which the 'hoppers rarely trouble as much as the lowland.

Caldwell County, Luling, April 21.—Grasshoppers are leaving Caldwell County by the million. Farmers jubilant.

Clay County, April 25.—Grasshoppers have not made their appearance around Henrietta yet.

Fayette County, April 25.—Grasshoppers are now moulting in good earnest, and will soon be ready to fly away.

De Witt County, April 25.—The grasshoppers seem to be disappearing.

Fayette County, April 25.—Grasshopper accounts conflict. Some say they have all hatched and are disappearing, while others say they are still hatching and are plentiful, but confine themselves mostly to the brush.

Grimes County, April 25.—Grasshoppers plentiful; a great many noticed going south.

Goliad County, April 25.—The grasshoppers in some localities are too numerous to mention individually.

Lavaca County, April 25.—Injury from grasshoppers is confined to small sections of territory throughout the county, and would not as yet average 5 per cent. damage.

Montgomery County, April 25.—We have no grasshoppers here.

Navarro County, April 25.—Grasshopper ravages in the neighborhood of Dresden are severe, considerable damage having already been done to corn, wheat, and oats.

Wood County, April 25.—The grasshopper plague has not reached Wood County.

Johnson County, April 26.—Grasshoppers leaving some sections of the county.

Lampasas County, April 26.—Grasshoppers have destroyed all the garden vegetables, and are now injuring the wheat.

Palo Pinto County, April 26.—Grasshoppers very numerous, but not doing much damage.

Waller County, April 26.—Grasshoppers are disappearing fast, and farmers have strong hopes that the crops will not be injured.

Wharton County, April 26.—No grasshoppers here.

Young County, April 26.—No grasshoppers here.

Grayson County, Denison, April 25.—Grasshoppers are making short work with vegetables and tender plants; they are still too small to fly, but are moving northward.

Austin County, April 27.—A few farmers on Kentucky Ridge and near Travis have been seriously damaged by the grasshoppers.

Clay County, April 27.—No grasshoppers in this county this season. Their progress in the counties east of us seems to be in a northerly direction.

Gonzales County, April 27.—Grasshoppers have commenced shedding their coats, unfolding their wings, and taking their departure. During the past week they have been seen passing over various portions of the county in a northward course. With few exceptions, crops have thus far suffered no material damage.

Limestone County, April 27.—Grasshoppers in certain localities are beginning to do serious damage to crops.

Robertson County, April 27.—Grasshoppers about as plenty as ever.

Washington County, April 27.—Grasshoppers are gradually disappearing.

Ellis County, Palmer, April 26.—Grasshoppers are passing northward slowly.

Washington County, Brenham, April 26.—Grasshoppers are moving northward, causing rejoicing among farmers.

Colorado County, April 28.—Grasshoppers rapidly disappeared last week, and there are now few localities in our county infested with them. Their ravages have perhaps been less than 3 per cent. in this section.

Fayette County, April 28.—The first grasshoppers seen going north passed over on Sunday, the 15th of April. During the first part of the week they seemed to be holding mass-meetings here and there, the weather being a little cool; but on Friday they went off by myriads.

Live Oak County, April 28.—Grasshoppers plentiful at Lagarta.

McLennan County, April 28.—Grasshoppers are damaging the young cotton on Mr. Will Kingsbury's farm, near this city.

Johnson County, May 1.—Grasshoppers are going off.

De Witt County, May 1.—The grasshoppers have at last taken wings, and are leaving for other parts as fast as they can go. The air for several days has been pretty thick with them.

Navarro County, May 1.—Grasshoppers are playing havoc with gardens on the outskirts of the city, but we are glad to learn that they are dying by thousands.

Robertson County, May 1.—The grasshoppers have disappeared from the neighborhood of Calvert.

Wood County, May 1.—There are no grasshoppers in Wood County.

Waller County, Hempstead, April 30.—Grasshoppers are disappearing.

Bastrop County, May 2.—The grasshoppers are reported to be rapidly disappearing.

Fort Bend County, May 2.—Grasshoppers here.

Hays County, May 2—Grasshoppers are coming and going. They go north as soon as they are able to fly. Their ravages so far have been quite exceptional.

Caldwell County, May 3.—Grasshoppers have done little or no damage in the black lands.

Dallas County, May 3.—In some portions of Dallas County, the grasshoppers have entirely ruined the wheat.

Freestone County, May 3.—Grasshoppers have destroyed a great deal of young corn and cotton in the western and southern portion of this county, and many farmers have been forced to replant.

Hamilton County, May 3.—In some localities, the grasshoppers are creating some uneasiness, but they are confined to a comparatively small area.

San Saba County, May 3.—The grasshoppers have taken all the wheat on Cherokee Creek except W. J. Key Kendall's, R. T. Barbe's, and D. S. Hanna's, leaving only about fifty acres that will make anything.

Fannin County, Bonham, May 2.—No grasshoppers here.

McLennan County, Waco, May 2.—The grasshoppers are flying high, going north.

McLennan County, May 4.—Mr. Sears, residing on the Bosque, poisoned myriads of grasshoppers with corn-meal and strychnine.

Travis County, May 2.—The heavens are clouded with grasshoppers going north; wind south.

Austin County, May 4.—The "Statesman" says the heavens were shrouded throughout the day by clouds of grasshoppers borne by southern winds toward the north. The width and depth of the vast volume of insect life was measureless.

Washington County, May 4.—The air has been full of grasshoppers going north.

Bastrop County, May 5.—No material damage done by grasshoppers except to gardens. They are moving northward.

Bell County, May 5.—Grasshoppers nearly gone.

Fayette County, May 5.—As soon as the recent norther stopped blowing, which was on the 1st of May, at the rising of the sun, there was a rising of grasshoppers also, and by one or two o'clock the whole heavens, as far as the eye could penetrate, was literally alive with them going north. Their depredations have been in spots, some sections being almost exempt.

Kerr County, May 5.—Grasshoppers are making nuisances of themselves about in spots, but no general damage is feared.

Lee County, Giddings, May 5.—Grasshoppers, having inflicted but small damage, are now rapidly emigrating.

Denton County, May 8.—The grasshoppers are fading away rapidly, after having done considerable damage to gardens and fields; but this damage has not been general.

Fayette County, May 8.—During the week, the air was filled with grasshoppers, gently wafted northward by the Gulf breezes.

Gillespie County, May 8.—On some farms about Fredericksburg the grasshoppers have destroyed the wheat, and cotton has been planted in its stead.

Johnson County, May 8.—The "Chronicle" learns that much of the wheat and oats in the vicinity of Grand View has been entirely destroyed by the grasshoppers. They are leaving, and corn and cotton will escape their ravages.

Leon County, May 8.—Grasshoppers have played out in this county, only a few patches being left, and they rapidly disappearing. They have done some slight damage to corn and cotton, but not enough to materially affect the crop.

Lampasas County, May 8.—We learn that the grasshoppers flying north alighted in the western part of the county on Tuesday evening. The ground covered by them extends from the Colorado River to within three or four miles of town. As a south wind still prevails, it is hoped they have gone by this time.

McLennan County, May 8.—Mr. Isbell, a farmer of this county, reports a field of oats of his which was completely devastated by the grasshoppers a few weeks ago as having come out again, or made a second growth, and that the crop will be very much better than if they had not visited it.

Colorado County, May 6.—For a few days grasshoppers have been emigrating in large numbers, but few remaining in the county. No further damages are apprehended.

Caldwell County, May 9.—Myriads of grasshoppers are still seen traveling northward.

De Witt County, May 9.—Grasshoppers have gone.

Falls County, May 9.—Grasshoppers in countless millions have been passing over, flying northward.

Gonzales County, May 9.—Grasshoppers have almost entirely disappeared. Full extent of damage sustained by farmers will not exceed one hundred acres, all told.

Hays County, May 9.—Grasshoppers are disappearing.

Live Oak County, May 9.—The grasshoppers are about all gone.

Wilson County, May 9.—Grasshoppers have avoided our crops and have confined their operations to the weeds that grow in the creek bottoms.

Wood County, May 9.—No grasshoppers in this county.

Washington County, Brenham, May 8.—Grasshoppers are doing no harm and are rapidly emigrating northward.

Bee County, May 9.—No grasshoppers here.

Fannin County, May 10.—The "News" says persons from vicinity of Savoy estimate half of wheat crop of that section destroyed by the grasshoppers. Ravages confined to west end of county.

Victoria County, May 10.—Grasshoppers have done no injury further than slightly damaging a few gardens in the northern portion of the county.

Brazos County, May 12.—Grasshoppers have almost entirely disappeared from this section of the county.

Colorado County, May 12.—The northwest wind in early part of the week brought a great many of the grasshoppers back to their starting-point. A great many young ones are also being hatched out, but it is said they do not live over twenty-four hours. At this writing they are again on their flight northward.

Fayette County, May 12.—From diligent inquiry of persons coming from the county we conclude that the damage done by grasshoppers in the whole county does not amount to more than 2 per cent. of the crops.

Bee County, May 15.—The grasshoppers have done but little damage.

Lampasas County, May 17.—Millions of grasshoppers were seen flying northward last week from the country south of here. The change of wind from north caused them to alight in great numbers; if they remain they will ruin the crops.

Navarro County, May 17.—Grasshoppers seem to be taking their departure for parts unknown.

Robertson County, May 17.—We have no grasshoppers now.

Wood County, May 17.—No grasshoppers in the county.

Navarro County, Corsicana, May 16.—Farmers report that the grasshoppers are disappearing rapidly.

Rusk County, May 19.—No grasshoppers here.

Tarrant County, May 19.—A gentleman from the country reports wheat in timbered section considerably damaged by grasshoppers. No injury on prairie.

Washington County, Brenham, May 18.—No signs of grasshoppers just now.

Navarro County, May 23.—Damage from grasshoppers believed to be less than 5 per cent. of crops.

Ellis County, May 24.—Grasshoppers have disappeared. Wheat and corn crops have been somewhat injured.

Lampasas County, May 24.—The grasshoppers have gone without having done much mischief, except to early gardens.

Brown County, May 25.—No injury of any consequence from the grasshoppers, and none feared, unless those hatched south of here alight on their way to the Rocky Mountains.

Clay County, May 25.—Grasshoppers have not disturbed the people at all.

Jackson County, Morales, May 24.—No grasshoppers here.

Llano County, May 26.—The grasshoppers have gone without doing much harm.

Wilson County, May 26.—Grasshopers have interfered very little with the growth of either corn or cotton.

Kendall County, May 29.—Grasshoppers did no material injury.

Lampasas County, May 30.—The injury caused by the grasshoppers to the wheat crop was not as great as was expeeted.

Burnett County, May 30.—Capt. D. T. Vaugan, a correspondent of the "News," says grasshoppers have done but little damage to vegetation.

Freestone County, May 31.—There is prospect of abuudant harvest, notwithstanding early ravages of grasshoppers.

Williamson County, May 31.—Grasshoppers have entirely disappeared, having done no damage of serious consequence to the year's crops.

Limestone County, Groesbeck, July 20.—Grasshoppers came here from the north last fall, about the 1st of October, coming with a cool norther, and traveling with about the same velocity as the wind. They remained about six weeks, and then left for the north, taking advantage of a strong south wind. Before leaving they deposited their eggs in great numbers, generally selecting for this purpose open places, such as fields or prairies, where there was no brush and but little grass. They constructed a kind of web or net, and placed it about one inch under the surface of the ground, placing it in a vertical position. There were sometimes hundreds of these cells or nests within a space of two or three feet square, each nest containing from twenty to twenty-three eggs. As the sun warmed the ground the eggs began to hatch, and the ground was soon literally covered with the young grasshoppers. They soon destroyed the gardens, and then went for the fields, doing a vast amount of damage. Many farms were planted over from one to three times. Having matured sufficiently, the young grasshoppers began to leave about the 15th of May, going in a northerly direction, always taking advantage of a strong south wind.

APPENDIX IV.

MISSOURI DATA FOR 1877.

LIBERTY, *April* 4.—The crop looks well at present, and I believe we will have over an average of wheat. Spring is backward, and, of course, can tell nothing about oats and corn. No grasshoppers here, and we do not expect them unless perhaps in flying swarms after they get wings; from these we do not fear any material damage this year.

SPRINGFIELD.—The prospects for wheat in the vicinity of Springfield are very good. No grasshoppers nearer than 20 miles; the grasshoppers have ruined nearly all the wheat in Dade County, coming within 15 or 20 miles of Springfield. There never was a greater preparation for a corn crop than is being made this spring.

KANSAS CITY, *April* 13.—We have no grasshoppers here nor any eggs, so don't expect any unless they fly here when they hatch. Wheat is reported looking better than for many years, and a good acreage sown.

SAINT JOE, *April* 13.—Crops look well in this vicinity: fair prospect for wheat; no grasshoppers in the immediate vicinity; they reached within 20 miles of here last fall. In the west and north, fears are entertained that they will do considerable damage where the eggs are deposited.

STEWARTSVILLE, DEKALB COUNTY, *April* 13.—The prospect for crops is excellent in this part of Missouri. We have no grasshoppers nor grasshopper eggs.

KNOBNOSTER, JOHNSON COUNTY, *April* 14.—Crop prospects are good. Wheat looks splendid. Not a grasshopper in this part of the county. Farmers are putting forth great efforts to make a large corn crop.

KIDDER, CALDWELL COUNTY, *April* 14.—The crop prospects in this place never looked more promising. No grasshoppers, old or young, have been seen this spring.

WARRENSBURG, JOHNSON COUNTY, *April* 14.—The wheat prospect is A No. 1; no grasshoppers in this section.—[*Saint Louis Globe-Democrat.*

We have had no locusts this year, except a few stragglers last fall from a swarm which passed down through Central Kansas and into Southwest Missouri.—[J. E. Gladish, Aullville, Lafayette County, April 15, 1877.

Continuous wet weather is retarding the hatching of the "hoppers" here. Snow this morning; thermometer thirty-five degrees above zero.—[John D. Dopf, Rockport, Mo., April 27, 1877.

CARTHAGE, JASPER COUNTY, *April* 30.—There are plenty of grasshopper eggs here, but none hatched out, and there is no fear that the damage will be serious when they do hatch.—[*Saint Louis Globe-Democrat.*

There was but very little damage done last season in this immediate vicinity, and but few eggs deposited. I understand, however, that in the southwest part of the county quite a number have hatched out. It is thought that a large proportion of the eggs was destroyed by the heavy cold rains. A year ago last summer they came from the south in a clear warm day, with a gentle breeze from that direction, commenced alighting between 10 and 11 o'clock a. m., and completely cleaned out the greater part of my crops; their departure was to the northwest.—[T. D. Wallace, Hopkins, Nodaway County, May 21, 1877.

Grasshoppers are now hatching out here. One gentleman says he counted eighteen coming out of one hole. They are now eating what is called smartweed. The farmers apprehend no danger from them.—[E. D. Barton, Sarcoxie, May 22, 1877.

I am glad to say that the locusts have not made their appearance in our locality; and that crops are in a pretty good condition.—[H. Carr Pritchett, Morrisville, Polk County, May 30, 1877.

In a few localities in this county the 'hoppers have hatched out in considerable numbers. They have eaten smartweed, but I think they have not yet damaged crops. Thus far the complaints nearly all come from farms adjoining the timber. Eggs apparently good are still in the ground unhatched. A stranger passing through the county in a carriage would not be likely to notice any 'hoppers.—[William H. Avery, Lamar, Barton County, June 7, 1877.

CARTHAGE, *June* 19.—The grasshoppers have appeared very thick in this (Jasper) county during the last few days, and are doing considerable damage. They are eating up the heads of wheat in a number of fields in the southern part of this county. The farmers in this county are very much alarmed, and say if they remain they will destroy their crops. The opinion here is that, as they are beginning to get wings and fly, they will leave here. Large numbers are flying north, and people may look for them north and east of here before long.—[*Saint Louis Globe-Democrat.*

We were not troubled with locusts during the past season in any part of our county, that I know of.—[T. W. Simpson, Payne's Prairie, Polk County, November 26, 1877.

I have the pleasure to state to you that the locusts in this county (Hickory) were not as plenty as the year previous. Only a few came into the southwest corner of the county; came from the southwest early in September; remained up to cool weather. I did not notice any of them lay eggs here; did not notice any young ones hatched here last spring. I live on a prairie farm near the southwest corner of the county. Heard of no complaint as to the locusts in any other part of the county.—[W. L. Snidow, Elkton, January 4, 1878.

APPENDIX V.

KANSAS DATA FOR 1877.

REPORT BY GEORGE F. GAUMER, SPECIAL ASSISTANT.

[From the monthly report of the State Board of Agriculture.]

STATE OF KANSAS, EXECUTIVE DEPARTMENT.
Topeka, September 12, 1877.

DEAR SIR: During the month of April I deemed it so important to the State to learn the condition and history of the then hatching locusts, in their subsequent development, that I asked the United States Entomological Commission to give the matter special attention.

Prompt notice was taken of this request, and Prof. C. V. Riley, chief of the Commission, came to the State, and after devoting considerable time to personal observation, appointed two resident assistants, whose report should be furnished to this office.

I now hand you, for your information and use, the result of this work. If in your judgment the reports contain information of public interest, they may be used in full or in part, as you may determine.

Very respectfully,

GEO. T. ANTHONY.

TO ALFRED GRAY, Esq.,
Secretary State Board of Agriculture.

Governor of the State of Kansas, Topeka, Kansas:

DEAR SIR: I send you Mr. G. F. Gaumer's report, as my assistant in making observations in your State, in the belief that you may desire to make use of it before it is officially published by the Commission. Taken in connection with my letter to you, and Mr. A. N. Godfrey's report, which I have requested him to hand to you, it will form a pretty complete record of the locust question in Kansas in 1877, up to the 1st of August.

Permit me herewith, on behalf of the Commission I represent, to acknowledge my indebtedness to you, who generously paid the sum of $225 toward defraying the expenses of the special assistants I engaged in Kansas; also, to thank you for your uniform courtesy and aid in the performance of work in your State.

Believe me, yours, very truly,

C. V. RILEY.

WINNEPEG, MANITOBA, *August* 27, 1877.

To the Members of the United States Entomological Commission:

GENTLEMEN: I have the honor herewith to transmit to you the final report of my observations on the habits and life-history of *Caloptenus spretus*.

My observations have been confined to the counties of Bourbon, Crawford, Cherokee, Labette, Neosho, Allen, Elk, Montgomery, and Chautauqua. My work for the Commission began May 20, and continued six weeks from that date. During most of the time the weather was cool, cloudy, and wet, so that little more could be accomplished than to record the appearance of the young locusts in the localities visited, and some few facts about the eggs and their hatching.

In presenting this report I desire to extend many thanks to Prof. C. V. Riley for the honor conferred by appointing me assistant, to Gov. George T. Anthony, and to the superintendents of the Kansas Pacific, Atchison, Topeka and Santa Fé, Leavenworth,

Lawrence and Galveston, Missouri River, Fort Scott and Gulf, and Missouri, Kansas and Texas Railroads, for free passes over their respective routes.

All of which is respectfully submitted.

GEO. F. GAUMER,
Assistant to U. S. Entomological Commission.

LAWRENCE, KANS., *August* 16, 1877.

At Fort Scott, May 20, I found the first locusts. They were very small, and not very abundant. The first colony was on a vacant lot in front of the Stewart Hotel. The ground was sandy and very compact, with a southern slope. A few eggs were unhatched. A larger colony was noticed in the southwestern portion of the city. The young locusts were perched upon the dead weeds and rocks, which scarcely covered the hard, sandy soil. Many egg-pods were either wholly or partially exposed by the action of the rains. The eggs thus washed out were nearly all spoiled. East of the city about two miles a colony of newly hatched locusts was seen. They were in a field which had been used as a pasture the previous summer. No eggs remained in the ground. Another small colony was observed to the south of town. Many examinations made for eggs proved that in the vicinity of Fort Scott few good eggs remained in the ground. Many of the eggs which were deposited in rolling land were washed out by the heavy rains.

At Girard, May 21, I found immense numbers of locusts, which were just hatching and making their way to the surface. The country is prairie; soil sandy and compact. Large numbers of unhatched eggs were in the ground, and in good condition. Every available spot of ground was filled with eggs, prodigious numbers of which were then hatching. The locusts had all hatched that and the previous day, as was clearly shown by their lighter color and more delicate look. It will be remembered that the weather, which had been cool and rainy, had changed to warm and clear on the 20th of May, and continued so for several days, during which time most of the locust eggs hatched.

In a drive of eleven miles in the vicinity of Columbus I noted seven colonies of locusts, which were quite young. In many places the surface seemed to be moving, so rapidly were the young coming up out of the ground. The soil was literally filled with unhatched eggs. When exposed to the air and sunlight, these eggs would burst into life. They were all in healthy condition; no parasites were to be found. The farmers, who supposed that the danger had passed, were taken by surprise, and many of them had come to town to tell what had happened, and learn what they could from each other. These men reported that the locusts were hatching in untold numbers all over the country. They confidently believed that the locusts would yet devour the crops, and every one was anxious to hear the best methods for destroying the young insects. I endeavored to see as many of these men as possible, and told many of them of the Paris-green mixture, and gave several of them small quantities of the poison to experiment with. Only a few have reported as yet. All agree, however, that the poison is a success when used in clear, windless weather. While on the farm of Mr. Blair, two miles west of town, I saw a flock of seventy-five young ducks, which in one hour and five minutes marched four times across his garden of five acres, in which many locust eggs had been deposited, and had commenced hatching about 10 o'clock. The insects were all picked up as fast as they came above the ground. After making a tour around the garden they plunged into a pool of water near the well, and, after quenching their thirst, were ready for another raid upon the locusts. No other enemies could be found preying upon them.

May 23, I made a trip up the Neosho River from Oswego, on the north side. Found locusts quite abundant, and at least a week older than any seen up to that time. They were devouring some gardens, but did no other damage. One man was fighting locusts by driving them into heaps of pine shavings, and roasting them. The experiment was a success, for he must have burned a bushel in a few hours. The eggs were all hatched in the Neosho bottoms, and most of the young insects had already disappeared. On the high prairies many eggs were yet unhatched, and the insects already out were small and showed no sign of developing an appetite for vegetation. Every effort to find egg parasites failed, although I found some which evidently had been parasited.

May 24 was spent in the vicinity of Chanute. A heavy rain cooled the air so much that the locusts did not venture from their hiding-places during the day, which was cool and cloudy. In company with George W. Ashby, I visited his and many other farms in the neighborhood, where the locusts had been hatching in the greatest numbers since the 19th of May. They had nearly all disappeared, but could nowhere be found dead. We found one colony on Mr. A.'s farm which had molted the second time, and were devouring some radishes. Less than one-half of the eggs were hatched in the vicinity of Chanute. Those in the ground were still sound, and hatched as soon as brought to the surface. The farmers who came to town reported that the

locusts were hatching in prodigious numbers all over the country, but that every rain destroyed all that were out previous to its fall.

At Thayer, May 25, I found locusts quite abundant, especially west of the town. They were all small and quiet, for the day was cool and cloudy. I opened the crops of four prairie chickens and six field plovers, and found them well filled with young locusts. Two maggots of the *Anthomyia* egg parasite were found in a batch of eggs east of the town. No other enemies were observed.

May 26, very few locusts were to be found in the vicinity of Cherryvale, and few had passed the second molt and were nearly ready for the third. They were very much scattered; only one now and then could be found. On account of the continued coolness of the weather, there may have been more locusts than could readily be seen. The farmers informed me that the locusts had hatched early in the season, and that they had all disappeared. They believed that they would all go the same way, hence did nothing to destroy them.

At Coffeyville, May 28, I visited many farms, and found the locusts very scarce, and larger than at any other place. They varied much in size; some were quite young, while many had passed the fourth molt. I saw two gardens which had been completely eaten out by them, and a few others injured to some extent. A field of wheat two miles south was stripped of its blades, but the grain was so near ripe that it was little, if at all, injured. The eggs were all hatched, and although many had been deposited, yet few insects remained.

I traveled from Coffeyville to Independence in a buggy, stopping many times to look for eggs, but failed to find any. Few locusts were to be found. Nowhere between the two towns had any crops been injured. The locusts did not travel as they are accustomed to do, but rather remained, like the native species, in the locality where hatched. I did not find a single colony during the summer which showed any migratory tendencies.

May 30, I made a tour through the eastern portions of Elk and Chautauqua Counties. Found two fields of wheat which were badly injured by them, and one field of corn, with now and then a garden or "truck patch." No large colonies were seen during the day. Now and then, small scattered swarms of half-grown insects were to be seen, mostly feeding upon wild weeds. Near Radical City I saw a farmer plowing a field, which had been turned very deep in October, 1876, for the purpose of destroying the eggs. These eggs had hatched, and the young insects, unable to make their way up through the solid ground, had perished in the attempt. The bottoms of the old furrows were frequently covered with their dead bodies. No locusts of any consequence were seen in the vicinity of Independence. A small colony was found in the northeastern portion of the city. Another, near Table Mound, was hatched in a corn-field, and took about half of the crop when it first came up.

At 1 p. m., June 16, the first winged locusts were seen flying over the Wakarusa. They were very high in the air. The wind at the time was blowing at the rate of about fifteen miles per hour, from a direction a little east of south, and the locusts were flying with the wind. The sky was nearly clear, and weather warm.

June 18, they again began to fly, at 11.45 a. m. The wind was south-southwest, and blowing at the rate of about forty miles per hour. They increased in numbers until 2.35 p. m., when there were a great many flying, as high as could be seen with the naked eye. At 3.30 many of them were quite low, and a few were seen to drop down, and they continued to fall until 4.30 p. m. At 5 p. m. they ceased to fly; and there was about one locust to every square rod. They flew very swiftly, and in a northnortheast direction.

June 19, I again visited the country round about Chanute. Found the locusts had nearly all disappeared. Those which had hatched previous to my first visit had all died in a few days afterward. The eggs were not all hatched, for in front of Mr. Ashby's house we dug up good eggs which had been deposited in a hard, sandy soil, and were overlaid with a deposit of sand about one inch deep, from an adjoining field. Most of them were spoiled.

At Parsons, June 20, I found the locusts molting the last time, and many of them already had their wings. Some were flying, but not in any considerable numbers. Few had come to maturity. At Chetopa they nearly all had wings, and had been leaving for two days. Several large swarms were seen feeding upon dog-fennel, but nowhere did they injure the corn or wheat. Nearly all the gardens in the eastern portion of the city were eaten up.

Locusts were observed flying over Lawrence in a northerly and northwesterly direction every clear day until July 10.

July 12 and 13, I observed them flying over Las Animas, Colo.

July 16, they were again seen flying over Napieste, Colo., and again, July 19, at Granada, Col.

Only a few specimens of *C. spretus* were found upon the ground in Colorado. A few locusts dropped down on Wakarusa from time to time. The largest number came

down June 22, at 4 p. m. They remained over night, and left the 23d, without doing any harm.

I attempted to raise a colony of locusts in the garden, but after the second molt a cold rain killed every one.

The native locusts are unusually scarce this summer. I have not observed a single specimen of *C. femur-rubrum* with wings. Only a few specimens of *C. bivittatus* have been seen, and other species are scarcely more abundant.

REPORT BY A. N. GODFREY, SPECIAL ASSISTANT.

DEPOSITION OF EGGS.

The invading swarms of locusts in the fall did not deposit eggs in loose, freshly-stirred soil. The locations most generally chosen for this purpose were those in which the soil was bare, and had become somewhat compact. Along the streams, preference was given to the south side next to the timber, and especially to the northward bends. On the high prairies, situations having a southern exposure were selected. Very few eggs were deposited in the prairie sod, unless so closely grazed by stock as to be almost bare. Roadsides, yards, and all situations where the soil is bare and sufficiently compact, are the favorite places of deposit, and more especially so if they have a warm southern exposure.

EGG PARASITES.

We derived a benefit by no means small or inconsiderable from the workings of small, unnoticed insects feeding upon the eggs. In some situations near Manhattan, the egg-feeding larvæ of different kinds destroyed from 15 to 20 per cent. of the eggs.

Several species of Carabid larvæ were found to devour the eggs, generally destroying only a portion of those in each pod, but attacking many.

Two or three species of Dipterous larvæ were found feeding upon the eggs. From two or three to six or more of these were found within each egg-pod attacked, which was soon reduced to a mass of empty shells.

A species of Hymenopterous larva was found in considerable numbers preying upon the eggs. This insect was always found feeding within the pod, or in the soil near the ruins of its late abode.

The larvæ of what Prof. Riley afterward proved to be a Blister Beetle (*Lytta cinerea*) also destroyed large numbers of the eggs. This insect entered the egg-pod, feeding upon its contents until the whole was destroyed.

HATCHING.

The locusts commenced hatching in the vicinity of Manhattan about the 6th of April. Very few could then be found, and it was only in the most favorable situations that any had hatched. A species of leaf-hopper (*Tettigonidæ*), which somewhat resembles the young locust in size and hopping movements, and which makes its appearance very early in the spring, was mistaken by many for the newly hatched locusts. This gave rise to reports of hatching two or three weeks before any locusts had really appeared. By the 15th of the month, the hatching had increased, though yet confined to situations most exposed to the warm sunlight. During the latter part of the month, hatching was much retarded by cold rains. On the night of the 29th, a heavy frost occurred, forming a crust upon the ground a half inch in thickness The next day was very warm, and hatching commenced as soon as the frost was out of the ground.

The young locusts as they hatched sought shelter through the night and during rains in grass and under leaves. There was a gradual disappearance of their number about as fast as hatched, but none could be found dead. But little vegetation had yet appeared, especially upon their hatching-grounds, and the temperature was generally so low that they moved but little, not appearing to leave their hatching-ground in search of food.

On the 1st of May, in a few exceptional spots of ground, nearly 90 per cent. of the eggs were hatched. Generally, however, not more than 15 per cent. had developed, and in cool, damp places hatching had scarcely commenced. The locusts issued more numerously on the 1st and 2d than they had hitherto done. May 3, the weather was very cool, and those already issued were inactive, scarcely moving from their place of concealment when disturbed. At first the locusts hatched and developed slowly, and great numbers were evidently destroyed by the cold and rains. Though the hatching had continued, with but few interruptions, from April 6, they were not by May 3 so numerous as at some time previous.

Hatching continued slowly to increase until the 10th to the 15th, when the earth seemed springing into life. No description can give an idea of the immense numbers which issued each day. The ground in some places appeared nearly white, from the little white pellicles thrown off by the hatching insects. The locusts always issued in great-

est numbers from 9 a. m. until noon. Very few were ever seen to issue in the afternoon, and none at all toward night. A warm rain seemed to favor their hatching, for they issued in increased numbers after each warm shower. The soil being warm and moist greatly facilitated their escape to the surface, but as a dry crust formed, they worked their way through it with difficulty. In light, warm, sandy soils the hatching was from two to four weeks earlier than in those of a heavy, tenacious nature. The eggs developed most uniformly in sandy situations, while in heavy clay soils the hatching process was greatly retarded, and extended over a longer period. Thus at Salina the hatching was about completed by the first week in May, while at Manhattan, where the soil is of a less sandy nature, the young locusts did not appear in greatest numbers until the 10th to the 15th of May.

In Brown and Nemaha Counties, but few locusts appeared before the 15th of May, and then only in small numbers. Here the soil is heavy and tenacious, containing very little sand. A slight difference in the composition of the soil makes a marked difference in the period of hatching.

REMEDIES.

1. *Plowing.*—Whenever the ground was deeply and thoroughly plowed in the fall after the eggs were deposited, the locusts failed to appear. This remedy is simple, and has proved very effective in every instance where tried. In locust years each farmer should fall-plow every field and roadside on his farm which contains locust eggs, and which is sufficiently loose to allow of deep plowing. The ground thus plowed should not be replowed in the spring, as in cases where this was done the eggs were brought to the surface and soon hatched. The object in fall-plowing is to cover the eggs with earth, which will become sufficiently compact during the winter to prevent their escape to the surface. If the eggs be plowed under after they have commenced to hatch in the spring, the locusts will still continue to hatch, and the soil will in many instances be loose enough to permit a certain proportion to escape to the surface.

2. *Harrowing.*—This, when practiced, was attended with good results. Where the ground was well and repeatedly loosened with a heavy harrow and the egg-pods broken and brought to the surface, no locusts hatched. This is best done during the fall, and should be repeated at intervals during the winter whenever the weather will permit. By this means the eggs are disturbed and brought to the surface, where they are exposed to the action of the weather and are greedily eaten by birds. The harrow can be used on all beaten roadsides and yards where the land is too compact to be well plowed. A few days thus spent by the farmer in using the plow and harrow will avoid much serious trouble and loss the following spring.

3. *Burning.*—This means was resorted to in different localities with some degree of success. One method of burning was to drive the locusts into the belts of dry grass around the fields, which were then fired, and thus many of the young insects were killed. Another and more effective method was to place narrow windrows of straw through the field, three or four rods apart. The locusts sought the straw for shelter during the night, and were then burned in great numbers. More straw was then placed upon the burned strips, and the process was repeated. The burned locusts are of a peculiar deep-red color, reminding one of boiled lobsters. The birds are said to have a special fondness for "roast 'hopper."

4. *Ditching.*—This was not very extensively tried in Kansas. Some farmers seemed to be entirely ignorant of the principles of ditching. One ditch, if it could be so called, was made by running a furrow near the edge of the wheat-field, and then returning in the same furrow, throwing the dirt the other way. This, of course, offered no impediment to the young locusts. Another ditch was about six inches deep and two or two and a half feet wide. This latter was equally ineffective, as any locust, however young, can easily leap a wall more than six inches high, if it is allowed two feet of "elbow room."

5. *Coal-oil.*—This has proved the most effectual remedy yet tried against the young locust. Coal-oil was used very extensively near Solomon City and Salina, where the merchants furnished the oil to farmers for this purpose at cost. Many devices were invented for its application.

[Descriptions of the different pans and other contrivances used will be found in Chapter 13 of the Report.]

NATURAL ENEMIES.

Weather and climate played a very important part in the destruction of the young locusts as they hatched. The eggs passed through the winter and excessively wet spring without any very great injury, the cold and wet seeming to have little effect whatever. During the early spring the weather was very changeable, a few warm, dry days bringing forth the young in abundance, to be followed by cold rains, checking their development, and killing numbers. During the last of April and part of May, this destruction kept pace with the hatching, so that at no time did the locusts appear to increase materially in numbers. After the warmer weather of spring and summer began, the locusts

seemed to thrive better, though they still developed slowly, and did not eat with that ravenous appetite which is so characteristic of the healthy locust. These conditions proved most effectual in those situations where the hatching was retarded by the clayey nature of the soil. Where the soil was warm and sandy, the locusts were less affected by the weather, and developed much more rapidly.

Birds.—Insectivorous birds were very effective in their raids against the pest. Great flocks of blackbirds passed over the State, settling upon the fields, and making terrible havoc among the locusts. It was amusing to observe a flock of these birds at work in a wheat-field, lunching upon a few hundred millions of locusts. The birds hopping about in pursuit of their prey, appearing for an instant above the green sea of wheat to sink again below it, strongly reminded one of a school of porpoises at sea. In fields where the locusts were very numerous, a visitation of a few hours from one of these swarms was sufficient to destroy nearly every locust in the field. Large flocks of plover were seen every day busily engaged at their meals, or passing over to other fields of labor. All our most common species of birds, the prairie chicken, meadow lark, ground-bird, quail, etc., seemed to appear in much greater numbers than usual. Everybody remarked the extraordinary number of birds of all kinds that appeared to congregate upon the fields and hatching-grounds of the locust. From their joyous notes and lively movements it was evident that the birds enjoyed their work immensely. That they destroyed great quantities of locusts was shown by their abundant droppings, consisting in great part of the eyes, thighs, thoraxes, and other indigestible parts of the young locusts. The amount of benefit which we derive from the feathered tribe is impossible to estimate or conceive. During the spring months a man would be arrested in the infested counties just as quickly for shooting a bird as for stealing a horse.

Toads were found in great numbers where the locusts were numerous. On examination, the stomach of a large fat fellow was found to contain twenty locusts, partially digested—some in the pupa state and some full-fledged. As many more, perhaps, were found in the intestines, more or less digested. It is readily seen that a few of these animals in a field would do no small amount of good.

A *Digger Wasp* was on several occasions observed stinging and burying the pupæ, depositing an egg upon each.

Flesh-fly.—Near Solomon City, and at other places also, at about the middle of June, great numbers of locusts were killed by the maggot of a large flesh-fly (*Sarcophaga carnaria*). This fly deposits its eggs upon the locust immediately after molting, while the parts are yet soft and damp. One insect was observed upon which the fly had deposited three eggs, placing them upon the soft hinder wing, near its base. The young maggots from these eggs entered the locust before it acquired its natural color and hardness. These maggots rapidly increase in size, feeding upon the internal soft parts of the locust, leaving only the thin, hard shell, through which they escape into the ground to undergo their transformations. Six or eight maggots are frequently found in the body of a single locust. The locusts attacked by this maggot become slow in their motions, listless and stupid, soon losing the power of flight altogether. They die when the maggot is about half-grown, seeking shelter under old weeds or rubbish. They are generally attacked at the change from the pupa to the winged state, but cases were observed where the insect was attacked at the molt preceding this.

FLIGHTS.

The first northward flight was from Texas, on the 1st day of May. This swarm, which was heavy and extensive, seemed to pass to the westward of us. Small swarms were observed in the western portion of the State at intervals during the latter part of May, flying north and northwest. These flights were not heavy, and but few alighted. The first flight which occurred over the central and eastern counties was about the 13th of June. The wind was then blowing a brisk breeze from the south; weather warm and clear; locusts not numerous, and flying very high. Swarms continued to pass, whenever the wind and weather were favorable, until the middle of July. The swarms were light, and very few dropped to the earth. These flights were all toward the north or northwest.

MANHATTAN, KANSAS, *August* 17, 1877.

NEWTON, *Harvey County*, *March* 6.—The people of this county feel a little serious over the prospect of our little friend, the grasshopper. The pleasant weather in the month just past failed to lure the little creatures out of their eggs. It is said a few did hatch, but they were somewhat like hens' teeth—they were not visible. Much plowing was done in February, and a few sowed a little, and nearly all are ready to put in their small spring grain. The ground is in a very fine condition, and plows easy; there will be a large spring crop put in. March came in with a cold northeast

wind, intermingled with light crops of rain; the 2d, 3d, and 4th were windy with flying snow. Yesterday and to-day the sun shone out, but the cold south wind kept it from thawing all the frost out of the ground.—[J. H., *Prairie Farmer*.

Jackson County, March 15.—Wheat and rye, large acreage sown, but nearly all destroyed by grasshoppers. Stock coming through the winter in fine condition. Prospect good for all kinds of fruit. 'Hopper eggs in countless millions all over the county, a portion of them injured.

Nemaha County, March 17.—Wheat and rye all taken by 'hoppers last fall: a little rye sown after they left; most of that did not come up until a few weeks since. Condition of all kinds of stock generally good. There will be a small amount of small grains sown this spring compared with other years. 'Hopper eggs nearly all in good condition, yet I am of opinion that deep plowing will destroy most of them.—[*Kansas Farmer*.

LEAVENWORTH, *April* 12.—The grasshopper question, which has been a brooding nightmare on the minds of the farmers and the people of Kansas generally, ceases to become the cause of general uneasiness when the true facts are known. A careful investigation into the subject shows that in Leavenworth County there are none worth mentioning, while in the eastern section of the State, where they have been playing havoc for two years, the damage apprehended is very slight indeed. In Jackson County, immediately to the west of here, the farmers say they care very little whether the grasshoppers come again or not, as they have enough grain now stored away to last them for two years to come. Millions of young 'hoppers have been killed lately by the changeable weather, which alternately froze and thawed them, and thousands of those remaining have met an untimely death at the hands of the outraged farmers, who have resorted to rolling and burning as a means for their extermination. The damage to crops throughout the entire State the present year will not amount to enough to produce any effect upon the farmers.—[*Western Farmer*.

[Correspondence Saint Louis Globe-Democrat.]

LOUISVILLE, *April* 12.—The wheat crop is looking very well; acreage small. No grasshoppers as yet; lots of grasshopper eggs in the ground. People are putting in their crops just as though there were no eggs.

CENTRALIA, *April* 12.—There are no grasshoppers hatched at this date, but there are millions of eggs. Farmers report that a large percentage are destroyed and will not hatch, though there are enough left.

LAWRENCE, *April* 12.—There are no grasshoppers in this locality, and we anticipate no trouble from them here, although they did damage in some of the western townships of this county and deposited eggs there. We understand the farmers in those townships are making efforts to destroy them as soon as they hatch. Wheat prospect good here.

HUTCHINSON, *April* 13.—The grasshoppers are hatching here in localities, but have done no harm yet, and seem to disappear as fast as they hatch. We think most of them perish. We do not fear those that are hatching here.

CHEROKEE, *April* 13.—In answer to your inquiries, I would say that the grasshoppers have not commenced hatching yet, and farmers feel confident that they (the 'hoppers) will not do any damage to their crops.

COUNCIL GROVE, *April* 13. No grasshoppers hatched yet. Winter-wheat that was sowed late is mostly in good condition, as are all spring crops. The very broad area of early fall sowing was all destroyed. Much was not resown. Spring is late, but the outlook is good, except grasshoppers.

JUNCTION CITY, *April* 13.—The general prospects for crops of all kinds are good. The greater proportion of fields of fall-wheat looks first rate; a few fields, very late sown, are poor. The grasshoppers, on warm days in favorable localities, are hatching out, but from some cause seem to disappear as rapidly as they come, and as yet have done no damage. The majority of farmers, however, are fearful of their expected depredations, and are holding back from making their usual spring purchases, making trade very dull.

FRANKFORT, *April* 14.—The grasshoppers are hatching by untold millions—not now larger than a buffalo gnat. Farmers are somewhat frightened, though many have faith in a good crop. Wheat looks fine, and is three inches high.

CARSON CITY, *April* 14.—There are some grasshoppers in this vicinity, but not doing any serious damage. There is a good prospect for crops.

MINNEAPOLIS, *April* 14.—The grasshoppers are hatching out pretty fast, and have commenced on some grain only on the outer edge. The old settlers don't fear any serious trouble from them. We are driving and burning a great many of them. It is reported that they are dying off. We contemplate to give them a warm reception from this time on. Would be thankful for any instructions as to the mode of destroying them. Will keep you posted.

FORT SCOTT, *April* 16.—It is now ascertained beyond a doubt that the grasshopper eggs in this section are unproductive. Experiments have been made, and in addition the

weather of the past few days has been warm enough to have hatched them by the million had the eggs been good, but not one of the pests can be found. Farmers are generally jubilant, and a big crop of everything is looked for in Southeastern Kansas.—[*Western Farmer.*

NEWTON, *April* 16.—The grasshoppers are hatching out numerously in this section. The farmers are trying to destroy them. The outlook for good crops is bad.

HIAWATHA, *April* 16.—From present indications we judge that the grasshopper will not be near as numerous as they were two years ago; and as we are better prepared to meet and fight them, we do not anticipate any serious damage to crops.

SABETHA, *April* 16.—The grasshoppers are hatching out in great numbers, but have done no damage.

NEOSHO, *April* 17.—Very little wheat was sown on account of the grasshoppers last fall. Wheat that was sown late looks well. This season is very favorable. Oats look well. Farmers are in the midst of corn-planting. 'Hoppers just beginning to hatch. Millions of eggs were deposited, and fears are entertained that they will do great damage.—[*Globe-Democrat.*

Pawnee County, April 18.—Winter-wheat is looking well; grain has been needing rain, but we are having plenty now. Rye, barley, and oats are growing well. We have no grasshoppers nor eggs, and everything is looking very encouraging in our county.

McPherson County, April 19.—Winter-wheat has a good appearance all over the county, and oats are up and looking well. Grasshoppers have hatched out in large numbers, but are confined to certain localities. We are preparing to fight them in an organized form. A heavy rain fell last night; we think it has killed many 'hoppers, though they are doing little damage at present.

Chase County, April 19.—Farming commenced in our neighborhood in good earnest some two weeks ago, and there is quite a large quantity of corn planted in our neighborhood. The grasshoppers are hatching out in great numbers in our county. Winter-wheat is in poor condition in our county, but will be better than many supposed when winter broke up. All spring grain looks well, and as our section has never been injured by the young 'hoppers, there are not many farmers afraid of them, and we are putting in all the land that is broken.—[*Kansas Farmer.*

Mr. A. N. Godfrey, one of our students, who is closely watching the grasshoppers fro Professor Riley, made a careful examination with respect to the effect of the late heavy rain-storm, and hands us the following:

"More hungry little grasshoppers made their appearance yesterday. The recent cold rains must have destroyed large numbers of the young larvæ, for they are not so numerous as they were a few days ago. The greater portion of the eggs are yet in the ground, waiting for a few more days of warm sunshine to develop them. We have many insect friends working for us,—more than a casual observer would suppose. In a few square feet some fifty egg-parasites of different kinds were found. Of one hundred egg-cases carefully examined, fifty-four were apparently sound and nearly ready to hatch, twenty were partially addled or eaten by parasites, and twenty-six were entirely addled or destroyed."—[*Industrialist* (Manhattan), April 21.

Since the 14th instant, the grasshoppers, in every burst of sunshine, have been boiling out of the College farm like so many little fountains; and with the utmost celerity and unanimity have found the nearest spear of grass or grain. For some days no material damage will be done, simply because the little whelps are not large enough; but that is an element which time will speedily change. Professor Riley's statement, made to us last fall after a careful examination, promises to be fully verified in this locality; namely, that if 90 per cent. of the eggs should be destroyed, the remaining 10 per cent. would supply 'hoppers enough to eat up the early crops. This section being the best part of Kansas has naturally taken better care of its eggs than have some other sections, if reports are correct, and we seriously doubt if 90 per cent. of these eggs have been damaged. At any rate, our prospect for a healthy and swarming crop of these jumping darlings is splendid—blame them!

We are devoutly thankful for the telegram from Fort Scott that the eggs in Southeastern Kansas are unproductive, and that not a 'hopper can be found thereabouts. However, nothing better could have been expected from that section; it is too near Missouri and the Indian Territory. The eastern end of the State also, having had its test in 1875, was very properly avoided by the northerly swarms last fall. Locusts know a good country when they see it, and, in the fullness of maternal sagacity, peg down their infernal eggs in those regions where fertile fields will insure abundant fodder for their beloved but unprincipled offspring.

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Seriously, there is no use shutting our eyes to the fact that until the middle of June many portions of the State will be more or less damaged. Every method which promises success in the destruction of the pest should be promptly and thoroughly tried. At the same time, it must be remembered that fighting 'hoppers is a new thing,

and we may not find the best modes in a flash. Furthermore, supposing the early crops to be destroyed, the probability of raising late crops this season is so great as to render wholly inexcusable any despondency in the premises. The State was never in as good shape as it is to-day. Riley County alone has 355,440 bushels of old corn on hand, and in the State there are over 36,000,000.—[*Industrialist*, April 21.

PLEASANTON, *April* 23.—There are no 'hoppers in this part of Kansas, except a few on one or two small streams. Farmers are in good spirits, and are pushing spring work. The outlook is all that could be wished.

BELLEVILLE, *April* 24.—Grasshoppers are hatching out in great numbers, but have not done any damage yet, being too young. The farmers are devising concert of action for their destruction.

PERU, *April* 24.—We have had very dry weather all spring, and have been wishing for a heavy rain to drown the 'hoppers. Day before yesterday we got the rain and hail with it, but not a grasshopper drowned. The rain was heavy, the fall being two inches in one hour, washing the loose surface off the ground, exposing the eggs, which under the rays of a hot sun began hatching by the million. They are now nearly all out, but grow slowly, and eating wheat and corn only in small spots, the blades being black with them. They hop in a northwest direction.

COUNCIL GROVE, *April* 24.—Crops are doing well. A small percentage of our grasshopper eggs have hatched out, but are doing little damage. There is promise of a good fruit crop.

WICHITA, *April* 24.—Farmers are very hopeful. The 'hoppers are leaving fast, and have not done any damage. Wheat, oats, and barley look well, better than for many years.

LOUISVILLE, *April* 25.—The grasshoppers are hatching out to some extent on the southern slope of the hills, but are dying off rapidly. The weather is quite cold.

WINCHESTER, *April* 27.—The prospect here is splendid. Wheat stands fully fourteen inches high, and the grasshoppers have almost entirely disappeared.

OLATHE, *April* 27.—There are no grasshoppers in this vicinity, and the prospect for good crops is excellent.—[*Saint Louis Globe-Democrat.*

EFFINGHAM, *April* 28.—There were a great many eggs deposited here, but no grasshoppers to be seen around. The general belief is that the eggs are spoiled, as they have not commenced hatching yet.

MUSCOTAH, *April* 28.—There were many eggs deposited here last fall. The eggs are not hatching to any extent as yet, and but very few young 'hoppers are visible. It is believed that, to a considerable extent, the storm destroyed many of them, but it did no damage to crops. The 'hoppers commenced hatching out three weeks ago.

NETAWAKA, *April* 28.—Eggs are deposited thick over this whole area, but only a few have hatched. It is thought the storm hurt them some, but not to any great extent. They have not damaged the crops at all yet. They commenced hatching during the warm weather of last week. None have hatched since the rains.

WETMORE, *April* 28.—There were millions of eggs deposited in this neighborhood, but they do not seem to be hatching except in the sunny side of the hills and the timber, and are not numerous. The cold weather has destroyed a great many. They devoured all the small grain that was put in last fall, but none this spring.

CENTRALIA, *April* 28.—Many eggs were laid. They are not hatching very much now. It is thought that the cold storms have destroyed the young 'hoppers to a great extent. They have done no damage so far. They began hatching out two weeks ago.

CORNING, *April* 28.—Many were deposited in this vicinity. Some are hatching; but 'hoppers are not numerous. It is believed that the storm has destroyed large numbers of them, as they commenced hatching out ten days ago. The eggs remaining are mostly damaged by the storm, and the opinion is that they will not hatch out.

FRANKFORT, *April* 28.—According to farmers' reports there were a great many eggs deposited. Some have hatched, but they are not numerous. Many claim that this storm will kill a very large amount of them. No damage to speak of done to crops yet. Commenced hatching about ten days ago.

IRVING, *April* 28.—There were a great many eggs deposited. The eggs are still hatching, and the young 'hoppers were very thick before this storm. But few can be seen on the ground to-day. It is believed that a portion of them hatched, and nearly all of the hatching 'hoppers were destroyed by the storm. They have damaged the wheat and some farms badly. The farmers think, if they do not continue their depredations further, that they will have two-thirds of a crop of wheat, averaging thirty bushels per acre. Crops look encouraging. The eggs commenced hatching about April 1.

BLUE RAPIDS, *April* 28.—A great many eggs were deposited, but from some cause most of them on uplands were destroyed. Along the streams a great many have hatched, but since the storm not one is to be seen. But very little damage has been done. It is thought most of the 'hoppers are destroyed. They commenced hatching about April 1.

WATERVILLE, *April* 28.—There was a large deposit of eggs in this district. They are

hatching fast, but it is generally believed that the storm has destroyed large quantities of them. Crops have partly been destroyed. They have been hatching for a month past.

LINCOLN, *April* 28.—The grasshoppers have hatched in immense numbers in this section, but many suppose a large number will perish, owing to the cold rains which have been prevailing here for the past few days. At present we cannot decide if any will be destroyed until the weather becomes warmer.

STERLING, *April* 28.—The grasshoppers that were hatched out are about all dead. Have examined the eggs, and don't think many more will hatch. The farmers here apprehend no danger from the 'hoppers.

TECUMSEH, *April* 28.—The snow and rain have killed nearly all the living 'hoppers. About half the eggs are not hatched. But little fear is entertained from them now.

SALEM, *April* 28.—The grasshoppers are all drowned or washed away, and most of the eggs turned yellow and rotten.

TABLE ROCK, *April* 28.—There are no grasshoppers to be seen here yesterday or to-day, and the general opinion is that the cold weather has killed nearly all of them.

DAWSON, *April* 28.—But few grasshoppers have hatched out yet, and I do not think more than one-third of the eggs will hatch. The farmers do not anticipate any trouble from the grasshoppers.

RULO, *April* 28.—The grasshoppers have not appeared yet in very large numbers, and have done no damage. By examination of the eggs I find that they are about ready to hatch.

ELK CREEK, *April* 28.—It commenced snowing here about 8 o'clock last evening and continued until this evening, and undoubtedly destroyed a great number of grasshoppers in this vicinity.

WHITE CLOUD, *April* 28.—No 'hoppers here yet.

IOWA POINT, *April* 28.—No 'hoppers here yet.

HIGHLAND, *April* 28.—There are very few grasshoppers in this vicinity. Four or five miles west they are more numerous, but not much trouble is anticipated from them.

TROY, *April* 28.—No grasshoppers here.—[*Atchison Champion.*

INDEPENDENCE, *April* 29.—Grasshoppers are here in great quantities, and the outlook is decidedly blue.

GIRARD, *April* 30.—There are no grasshoppers in this section of the State, and no prospect of any from the eggs deposited here last fall, as they seem to have been too badly frozen to hatch.

COFFEYVILLE, *April* 30.—'Hoppers were washed away in great numbers by the late heavy rains. A few are left, but they have done no damage except to a few gardens, and there is no alarm among farmers. Crop prospects excellent.—[*Saint Louis Globe-Democrat.*

During the last week in April.

The grasshoppers have been hatching out in large numbers in this county for some days past. As we have said before, they are confined to spots principally, and that generally in sandy soil.—[*Newton Kansan.*

Grasshoppers have hatched out by the million in the field west of the depot. They seem to have the old natural propensity fer "chawin' things," and have already attacked the fall-wheat.—[*Chase County Leader.*

Mr. F. P. Endicott, road-overseer, has declared war with the grasshoppers, and called out the hands and gone to driving and burning them, and we hope all overseers will do likewise.—[*Arkansas City Traveler.*

Many thousand acres of corn have been planted by Sumner County farmers during the past week.

The young grasshoppers hatched out last week have entirely disappeared from some localities.—[*Sumner County Press.*

Friday and Saturday of last week, and Monday of this, the grasshopper war progressed with considerable vigor. All the various methods have been tried with varied success, and there is still a difference of opinion as to the best method of fighting them.—[*Dickinson County Chronicle.*

The grasshoppers are getting worse. Some farmers are making effective war upon them. They are not so numerous in the county as to make it impossible to annihilate them. If the grain-growers will only fight them they will not do much damage, but unless active war is made upon them the grain crop will be shortened.—[*Winfield Courier.*

A petition was circulated and signed on Monday, in compliance with the law, requesting the road-overseer to "order out the men," which he did, and a few days later five different gangs, four to a gang, were busily engaged fighting the voracious grasshoppers. The music will be kept up from day to day until the last of the race shall have been fanned into "eternal oblivion."—[*Dickinson County Gazette.*

The grasshoppers are hatching and growing, and the farmers are worrying them in every conceivable way by rolling them, by burning, and other means, while the little birds are doing good work for their country. A few days more, and we can tell if they are to be master of the situation. At present writing we think not.—[*Mitchell County Echo.*

I have seen parties from different portions of our county yesterday and to-day, and they all agree that we will not be troubled by the grasshoppers or locusts this spring. No small ones just hatching to be seen, although a great many eggs were deposited during the fall. Only one of my informants claims to have seen any; he stated that he had seen a few that appeared to be three weeks old, but that he had not seen any after diligent search that appeared to be just hatched. One party had examined some eggs deposited in an orchard, and another those deposited in a wheat-field, but they found none hatching, and after breaking open and examining the cones they claim they will never hatch. The eggs were deposited in ground free of grass, such as tramped lots, roads, hillsides, and orchards; also in plowed lands and wheat-fields. Many have tried to hatch them in warm rooms and in the sun without success. Should anything transpire in future worthy of mention I will notify you. My opinion is that there are two reasons to suggest why they should not hatch. One is that they were very late in reaching here, and probably debilitated and exhausted; and the other is that owing to the warm fall the eggs were started and a few were actually hatched out, and the severe and continued cold weather destroyed their vitality.—[J. H. Brown, Fort Scott, May 2, 1877.

Xenia, Bourbon County, *May* 5.—The 'hoppers are not hatching yet, but the eggs seem all right, and no doubt will pan out a lively specimen to every one of them; but as they are fully a month behind the time of hatching of two years ago, and as vegetation has got a good start, there will be plenty for them to eat, and but little fear is entertained of damage to crops.—[E. J. T., *Prairie Farmer.*

Phillips County, *May* 9.—Grasshoppers can stand sudden freezes and thaws to a great extent, but the weather we have had for a week past, of cold, drizzling rain, with a trifle of snow, has been too much for them; it left them hanging so long between life and death that they had finally to give up the ghost. Two weeks ago a severe hail-storm pounded many of them to death. Nature has favored this section of Kansas, and we all feel jubilant.

Reno County, *May* 9.—'Hoppers laid their eggs plentifully on suitable ground sod that had been turned over in the spring, and in every dry knoll and garden. They all hatched in March and threatened to do considerable damage in the neighborhood, but the very cold rain since has cleared them off, and we can find no 'hoppers. We feel very much relieved for the present. Our only danger is from "raiders."

Osage County, *May* 9.—We are having a very wet, backward spring, which will make planting late. It is "dead medicine" for the 'hoppers. Have made close observation, and find fully three-fourth sof the 'hopper eggs are spoiled. One noticeable help for us is the unusual number of birds which kind Providence is sending to destroy the 'hoppers, and they are doing it. We are full of hope. Expect a big crop.

Butler County, *May* 9.—Grasshoppers commenced hatching on bottom lands the last week in March; on uplands a week later. They came out in appalling numbers along the streams, but in limited patches on higher situations. A very small percentage of wheat has been destroyed, and scarcely any other damage done. Farmers have used various methods for the destruction of the 'hoppers, with a fair degree of success. Natural agencies—probably cool, damp weather and heavy rains—are causing their rapid disappearance.

Dickerson County, *May* 9.—The grasshoppers' eggs in this vicinity were not killed by the frost in March to any extent, but the cold rains in April have destroyed many; besides the plover and blackbirds are eating millions of them. There seems no more to-day than there was three weeks ago.

Atchison County, *May* 9.—No grasshoppers hatched yet, and we hope none of the eggs may be alive. The parasite is preying upon them, and the winter killed many, so the farmer feels that these great enemies to his crops may be greatly if not altogether disposed of.

Barton County, *May* 9.—We hear occasionally of a small tract of ground being very thickly settled with 'hoppers, but have no fears that our crops will be damaged by them. The weather has been very cold and wet for the last week, which has no doubt been in our favor.

Crawford County, *May* 9.—No 'hopper eggs yet hatched. Very few eggs to be found now. Spring has been very wet, and spoiled most of them. Farmers are not alarmed, unless they come in from other States.—[*Junction City Tribune.*

Hutchinson, Reno County, *May* 10.—There are possibly enough 'hopper eggs yet unhatched to keep the birds in fair condition for a week yet, but certainly no more, and a live 'hopper cannot be found in the county. The scare is over and our farmers

jubilant over the wheat prospect, which is finer than ever before known, whole fields averaging 25 inches in height.

NEWTON, HARVEY COUNTY, *May* 10.—The few 'hoppers hatched of late have simply served as the daily bread of the birds. There are possibly a few unhatched eggs in heavy ground and upon the north side, but they won't average 2 per cent., and no one cares whether they hatch or not. In sandy soil and on south-side slopes there are absolutely no 'hoppers or eggs. Wheat is growing rapidly, and could not look better, standing in many fields twenty to twenty-four inches high. None of it was damaged by hoppers, and the yield promises to be something enormous.

FLORENCE, MARION COUNTY, *May* 10.—Heavy rains and protracted unseasonable weather destroyed pretty much all our early crop of 'hoppers. Occasional fair days of late have brought out a good many in spots, and, generally speaking, every day now shows newcomers. But from some unknown cause the young 'hoppers die almost as fast as they hatch, and the birds, which are far more numerous than ever before, pick up innumerable numbers, dead and alive alike. There are yet in the ground many unhatched eggs bearing evidence of vitality, but the fate that has so invariably befallen those hatching gives our farmers confidence that there is but little to fear from them. No damage has been done to wheat by them, and though, owing to last fall's depredations, our crop will not be what it would have been otherwise, still all that was left and more that was planted is in fine shape and promising a good yield.

COTTONWOOD FALLS, CHASE COUNTY, *May* 10.—'Hoppers have hatched in spots all over the county, and still continue to, but have done no damage, and many of our people have about given up the notion that they are likely to in the future. There is no question but what there are a good many eggs yet unhatched in the ground, but they will have to show a good deal more vim and bottom than those thus far hatched to scare us much. Birds flock over fields in countless numbers and scoop in the dead and kicking so fast that it isn't by any means an easy thing to find a gill now where once they were to be had by the bushel. All late-planted wheat is looking well, fully three-fourths of that eaten by the 'hoppers last fall having been replanted.

BURLINGAME, OSAGE COUNTY, *May* 10.—Nearly if not quite all the eggs hatched in these parts as yet have been destroyed by the rain or eaten by the birds. Regarding the eggs not yet hatched there are various opinions, the ruling one being that they may hatch and be hanged for all it will frighten our people. There are a good many eggs still in the ground.

TOPEKA, SHAWNEE COUNTY, *May* 10.—About three-fourths of the wheat crop was destroyed by grasshoppers last fall. The devastated fields were not resown, and consequently the present area of wheat will not exceed 5,000 acres, or about the same as in 1875, and one-half of last year. The present crop is in the best possible condition, and promises a yield in bushels per acre much larger than last year. An immense amount of corn is being planted, and some think that when all is in the acreage will reach 50 per cent. above last year, when it was 42,249. Grasshoppers are hatching out in some places in the western portion of the county, but they disappear before they get big enough to do damage. It is the prevalent feeling among farmers that the danger is nearly, if not quite, passed. The fruit outlook is unprecedentedly good.

WINFIELD, COWLEY COUNTY, *via* WICHITA, *May* 10.—What with the cold rains, frosts, birds, worms, and the systematic destruction by our farmers, the 'hoppers have had hard rows to hoe in this county. Though large numbers have hatched, little, if any, damage has been done, and our people are as good as over all scare.

MCPHERSON, MCPHERSON COUNTY, *via* NEWTON, *May* 10.—Though we have still in the earth an abundant supply of eggs, and have daily hatches, the 'hoppers do no damage, and in one way or the other manage to leave this world without so much as a remembrance, except the scare. Some of our people still affect timidity, but it is much less aggravated than some weeks ago. The majority, however, are satisfied that the good time is now coming sure.

STERLING, RICE COUNTY, *May* 10.—Few eggs were laid here last fall, but there have not been enough 'hoppers at any time to create apprehension, and as all the eggs have hatched and the young 'hoppers are all dead, we have no further interest in such matters.

EMPORIA, LYON COUNTY, *May* 10.—Word from all sections is positive that there are no more grasshoppers, and that the few eggs yet in the ground will, if they all hatch, serve but to manure the soil and make it richer.

WICHITA, SEDGWICK COUNTY, *May* 10.—The grasshopper has seen his day in these parts. He is no more, and the same may be said of eggs.

EUREKA, GREENWOOD COUNTY, *via* EMPORIA, *May* 10. While grasshoppers have been with us more or less for months past, they seem to be innocent, harmless little things compared to the beasts their ancestors proved to be in the years gone by.

ESKRIDGE, WABAUNSEE COUNTY, *via* BURLINGAME, *May* 10.—Reports from all over the county generally agree to the effect that the 'hoppers' days are numbered, the energetic way farmers have scooped them, and the natural weakness of the critters, rendering the situation right encouraging.

VALLEY FALLS, JEFFERSON COUNTY, *May* 10.—No eggs, no 'hoppers, and wheat looking better than ever before at this season of the year.

GREAT BEND, BARTON COUNTY, *May* 10.—Still have to report no 'hoppers, which is not strange considering we had no eggs. Wheat is simply in perfect shape, the growth remarkable.

LAWRENCE, DOUGLAS COUNTY, *May* 10.—The few 'hoppers on the border of the county have gone whither no one cares—long as they have gone.

COUNCIL GROVE, MORRIS COUNTY, *via* EMPORIA, *May* 10.—We are decidedly pleased with the outlook, as the 'hoppers worry us not and the crop prospect is something to remember for years.

DE SOTO, JOHNSON COUNTY, *May* 10.—Eggs none; grasshoppers ditto. Wheat is looking a great deal better than ever before at this time of the year.

KINSLEY, EDWARDS COUNTY, *May* 10.—No eggs, no 'hoppers, and it is still the now almost stereotyped report from us that never was there such a prospect for crops of all kinds in this county.

OXFORD, SUMNER COUNTY, *via* WICHITA, *May* 10.—Grasshoppers are now of the might-have-been-with-us, and no longer excite attention to speak of.—[Extracted from special dispatches to the *Journal of Commerce.*

All things considered, the locust prospect for this vicinity is not very encouraging. With us the hatching process has but fairly commenced, and yet even now myriads of the young locusts have appeared. At the west and south, where the soil is lighter and warmer, general hatching was completed some two weeks ago. This difference in the time of hatching is due to the difference in the nature of the soil, whether light and warm or cold and tenacious. This late hatching is beneficial in giving the egg parasites and their natural enemies, such as snakes, birds, etc., an opportunity to do greater execution.

Although numbers of the locusts which first hatched have perished from the inclement weather and other causes, yet those now hatching and yet to hatch will live under more favorable conditions. We may therefore expect fewer natural deaths among the locusts than we have hitherto enjoyed.

The eggs were deposited in such numbers here, and so many are yet unhatched, that we may expect to fight for our crops if we would save them. In most of the southern and western portions of the State, the prospects are brighter than they are at present with us. They have only the locusts now hatched to contend with, while we have almost as many now with us and many more coming. Because other portions of the State are comparatively save, we must not expect immunity from the pest.

It is now evident, from the number of young locusts above ground and the number of eggs beneath, that unless we give this subject close attention, with strong and united action, we may expect to suffer. The effect of combined, determined action in destroying the locusts is well shown in some parts of the State. All who show the white feather now, deserve to suffer. We cannot remain inactive on the supposition that the locusts are dying off and that no danger need be apprehended. True, they "die off" at a rapid rate when visited by a flock of blackbirds or plover. Although many die while hatching or molting, we cannot safely rely upon this natural means of getting rid of the 'hopper. All insectivorous birds are our best friends, and should be jealously guarded not only this year but for years to come, for we may need their assistance again.—[*Industrialist*, May 12, 1877.

Grasshoppers have been hatching out for the last two months in this vicinity and disappear without doing much damage. There were vast quantities of eggs deposited on my place last fall. Some of the ground I harrowed soon after, and exposed the eggs to the frost of winter and to the birds. Some of it I harrowed early this spring, and drilled to oats, thereby throwing the eggs to the surface and exposing them to the birds. I have 22 little pigs that have done good service in one field, rooting the ground thoroughly wherever the eggs were deposited, in quest of the same, upon which they seemed to do first rate. Fourteen acres of such ground I plowed early in February, 8 inches deep, and sowed to spring-wheat; 32 acres I have plowed the same depth since the middle of April, and planted with corn. I also have 15 acres of winter-wheat sown the 5th of October, which is looking first rate, and so far the 'hoppers have not done me 10 cents' worth of damage, and I don't believe they will. To help the matter, we are having a very wet spring.—[Solomon Whitney, Manhattan, Kans., May 15, 1877.

Yesterday at Troy, the county-seat of this county, no young locusts or eggs could be found. They did no damage last fall, very few descending to the earth. Reports say that very few passed over the eastern part of the county. Toward the western part of the county the locusts last fall had eaten strips from two to five rods wide in the wheat-fields. These strips so far as observed all extended along the north side of the field. All these strips had been resown last fall or this spring, and are growing nicely. Could find no locusts whatever at Severance, and but very few egg-pods. I send by this mail a small box containing egg-pods found. They are all very much alike in appearance, appearing to be addled. The prospects are good for a bountiful wheat crop through this section.—[A. N. Godfrey, Severance, Doniphan County, May 16, 1877.

The young have hatched in great numbers, but a great many have been destroyed by the unusually wet spring. Still, enough remain alive, or to be hatched, to do great damage. Indeed, even now whole fields of wheat and oats have been totally destroyed, and corn, which is now just coming up, is being attacked.—[A. H. Gleason, Little Sioux, Harrison County, Iowa, May 21, 1877.

But my opinion, after riding to and fro over patches a dozen square miles, is that around the timber and along the warm lands there have been enough hatched to do very serious injury, especially if warm, dry weather comes for the next month.—[J. E. Todd, Tabor, Fremont County, Iowa, May 24, 1877.

I think about ten days after you were here we had some few days of very warm, dry weather, which brought out millions of the insects, but they do not seem to be as generally distributed this season as two years since. They seem to vanish nearly as fast as they hatch; where they were thick four weeks since there are scarcely any to be found, and it is quite certain none have matured. There has been no injury done to crops in this vicinity from the present crop of insects.—[A. W. Fellows, Parsons, Kans., May 25, 1877.

Within the past few days quite a number of grasshoppers have been hatched out in this vicinity, in favored spots, quite thick. Yet, from indications, they seem to be going the way that all young Kansas 'hoppers have gone this spring. We have had immense floods lately, and I think this is helping us very much.—[A. S. Johnson, Land Department A., T. and S. F. Railroad, Topeka, Kans., May 22, 1877.

Yesterday was spent in the vicinity of Thayer. Found the locusts quite abundant in places. All were quite young and very stupid from cold. They were quiet most of the day, and are doing no damage. To-day I have been to Cherryvale. Find fewer locusts and very few eggs; found some which were about two weeks old. The days have been cool and damp, and they have not moved about any.—[George F. Gaumer, Cherryvale, Kans., May 26.

A great many of the 'hoppers hatched previous to this date have been destroyed by some parasite, but it appears that within the last few days the 'hoppers are becoming more numerous, and a great many have serious fears that they will come in sufficient numbers to destroy the major portion of our crops this year. They appear to be hatching more numerously in and near the timber belts than any place else. Some of our farmers are much downhearted, while others are still jubilant and in high hope that they will not do us any serious damage. One thing is certain, if they come in such vast millions as they did in '75, and remain as long as they did then, it will be too late to raise any crop at all after they are gone; but this portion of Kansas is in a far better condition to stand a raid from these pests than she was in '74 after the drouth and chinch-bug year of '73.—[W. L. Lanter, Garnett, Kans., May 28, 1877.

I have received your circulars and bulletins, for which you have my thanks. A few grasshoppers hatched in this vicinity during the warm days in February, and people were very hopeful that the eggs would be so *quickened* that they would be destroyed. Probably large numbers were, as they seem just now, for the most part, to be hatching on the dry, sandy knolls or knobs. For three or four weeks past they have been slowly hatching in such sandy spots and along the roadside where grading has left exposures of solid clay; but until within a few days they have not seemed to be growing or threatening much damage. But on Saturday last Mr. J. D. Sells, a friend of mine, who lives on the line between this county and Wright, six or eight miles northwest of here, was in town telling that he had had twenty-six acres of wheat utterly ruined by the insects. Similar stories, though not placing the damage so high, had been told by other farmers; but, as this is the season of "croaking," little attention has been given the matter. I therefore went out to his place on Sunday (yesterday) to see for myself. I found his story true in every respect. He had sown twenty-six acres of wheat on high and dry ground—prairie, broken last season. It came up finely, and gave promise of a splendid crop, and was at least six or seven inches high when the grasshoppers began their work on it a few days ago; but they had eaten it all up except less than half an acre, and were closing in upon that very fast. A portion of the field he had already plowed and planted with corn, and is to-day at work to replow and plant the remainder. Not only had they eaten the wheat, roots and all, but there were none of the soft, succulent weeds left. They had left their "chips" everywhere. The ground was as clear of vegetation as the surface of a brick-yard. After thus eating the bulk of the wheat, the insects congregated on an adjoining piece of rolling prairie, near a skirt of brush, on which the grass had not been burned last autumn, no doubt for the purpose of living off the very tender young grass which was springing up. During a high wind Mr. Sells set fire to this dry grass and made a holocaust of them. He thinks he must have burned at least twenty bushels, as the ground was black with them.—[Charles Aldrich, Webster City, Iowa, May 27, 1877.

In this part of the county, no locusts have hatched out; only a few, which were brought into the house and hatched by the stove. For the last six weeks the egg-pods

were diminishing, though for my part I did not anticipate that any amount would hatch out to do any injury. We are safe, as no eggs can be found; should any visit us on their turn to the north, from Texas, I will notify you.—[Jas. Hanway, Lane, Franklin County, May 20, 1877.

HIAWATHA, BROWN COUNTY, *May* 16.—Here about 50 per cent. of the eggs will not hatch. A very few locusts have recently hatched, the first having appeared about a week ago. The soil is cold and heavy, containing little or no sand.

SENECA, NEMAHA COUNTY, *May* 17.—Here, on a sandy knoll, the eggs have been hatching for four or five weeks. Near this knoll a few locusts were found, which had passed the second molt, and from this size all gradations could be found, to those just hatching. At other points, away from this one sandy spot, the hatching was very much less advanced, the locusts having but recently commenced to appear. The eggs here are principally sound. They were not deposited so thickly as at Manhattan. The soil is black and heavy, and contains very little sand.

Between Seneca and Hanover the wheat crops are looking well. Some few fields are partially damaged, but the injury had soon ceased.

At Hanover, Washington County, the soil is more sandy and dry, and the eggs are all hatched. Sound "hoppers" not numerous.

WASHINGTON, WASHINGTON COUNTY, *May* 19.—The streams are swollen by the continued heavy rains. Observed many locusts floating upon the surface of the water, but no dead or drowned ones could be discovered. The supports of the railroad bridge at this place were almost covered by the locusts which had drifted upon them and crawled up the sides. They were drifting from a piece of lowland which had been overflown, but in the center or opposite side of the stream none were seen. The eggs are all hatched in this vicinity. Found empty egg-cases in abundance, but none yet to hatch. The locusts are very numerous in some fields, but, from reports, have disappeared considerably. Their "disappearance" seems to be caused principally by the locusts scattering, as they are very abundant in the young prairie-grass. The locusts here have a lighter shade of coloring than I have before met with. Some have passed the third molt. The soil is light and sandy.

CLAY CENTRE, CLAY COUNTY, *May* 23.—Locusts generally very large, being in the fourth larval stage. A very few, however, are now hatching, delayed, I think, by fall plowing. But little injury has been done.

MANHATTAN, RILEY COUNTY, *May* 24.—The prospects are very encouraging. About 90 or 95 per cent. of the eggs have been hatched. The hoppers are not so numerous as they were two weeks ago. They are doing no particular damage on the College farm, being most of the time collected in compact groups. They are very dark in color—darker than any I have seen before. They are dying in considerable numbers in the College rye-field. The rye is now in flower. I send specimens of dead locusts. These dead ones are found mostly in the open spots where they congregate. They seem to be feeding but little, and developing slowly.

INDEPENDENCE, *May* 30.—Yesterday (May 29) I came in a buggy from Coffeyville to Independence, making a long trip, south and west, to the south line of the State. Found fewer locusts than on any previous day. Most of them were quite large, between the second and third molts. No eggs remain unhatched. Two gardens were destroyed and one field of wheat slightly injured by them. In every case the insects had disappeared immediately after doing the mischief. To-day I was west and south in Elk and Chautauqua Counties. Found three swarms of locusts doing considerable damage, two in wheat and the other in corn fields. Swarms quite local. Burning is the only thing done for their destruction in the country over which I have traveled to-day. The young were driven into heaps of hay and then burned. Saw one man turning a field, which had been plowed quite deep last fall to destroy the eggs. They had all hatched, and perished in the ground in their attempt to escape. In places the ground was quite red with their dead bodies when exposed on the surface. I have been unable to try any experiments to-day on account of high winds and scarcity of locusts.

GREENLEAF, WASHINGTON COUNTY, *May* 21.—Eggs were not thickly deposited at this point, and are not hatched. Locusts not numerous, and are doing no particular injury.—[Reports from special assistants.

The deposit of eggs last fall covers an area approximated at 15,000 to 18,000 acres. Fully one-half were destroyed by frost and water. By the 1st of May one-third of the remainder was hatched, but were of short life. The early hatching commenced and generally continued upon the low lands. These fellows disappeared as quickly as they came. At one place I saw them so thick that they looked like wheat thickly sown. Up to the middle of the month all that were hatched died. But a small portion of the eggs left, say 10 per cent., continue to survive. By this I would mean of eggs not hatched, or one-half of one per cent. of all deposited.

Some of the farmers complain of their young corn as having been eaten. Meetings have been held under the late laws of the State, and the general plan for killing them

is two wings of canvas and a hole at the convergent point, thus: ⋀. Trenches are resorted to by many. A sheet-iron, eight to ten feet long, having compartments or divisions filled with petroleum, something after the fashion of a sorghum evaporator, with a high back, is placed upon wheels, whose axle is shaped to draw the iron near the ground, is used by a few. The farmers are about equally divided in opinion as to the prospect of future damage, some claiming on the one hand that they will disappear, and cite certain years in which they went away or died. Men of this opinion are principally old settlers. Others have a directly opposite opinion; but they are, I believe, a class of men generally known as chronic grumblers, and are new-comers.

Taking into consideration the inclemency of the weather, it being cold and wet, and the unhealthy condition of the egg, I am of the opinion that the damage will be very slight. My own experience is that they are not as strong and healthy as those of last year, and of a paler, more delicate color. I have specimens of them in all stages preserved in alcohol, and I notice a vast difference in the two years. Thursday I brought in a box of eggs, containing at least 300, and set them in a south widow, slightly covered with loose earth, and up to this time not one-fifth of them have hatched.—[E. M. Sanford, Burlingame, May 27, 1877.

CHANUTE, *May* 27.—Less than one-half of the eggs are hatched here. Those in the ground are still good, and hatch as soon as brought to the surface. The ground is very wet and heavy, and this, I believe, is what prevents the hatching.

This afternoon I have traveled on horseback over as large a tract of country as possible. Found very few locusts more than three days old; myriads of young ones; very little damage being done by them. Nothing is being done to destroy them, for people believe that they will all disappear of their own accord. The weather has been very hot (90° in shade) for three days.

COFFEYVILLE, *May* 28.— To-day I have visited many farms in this region, and find the locusts comparatively scarce, though larger than any yet seen. They are very variable in size. The same swarm often contains all sizes, from the smaller to those which have passed the third and a few even the fourth molt. Very little harm is being done by them. Some few gardens are being injured, and I saw one field of wheat a part of which was taken by them. In answer to my inquiries, the farmers say that many locusts hatched early in the season, but have all disappeared. They do not apprehend any trouble from them this summer.

I find no unhatched eggs in the ground. Some Paris green was put out late last Saturday evening, and changed several times yesterday. In the evening I found a great many dead locusts, and the ground round about the poison cleared for twenty feet or more. A few hours after the bait is set they begin to hop toward it, and fall to eating vigorously at first. Suddenly they stop, make one or two long jumps, and stop, stretch, first one leg and then another, and lastly the long or hopping legs; with these latter they make a few quick, involuntary motions, and then turn over and expire, some in one minute, others live four or five minutes.—[From special assistants of Commission.

May 30, saw Prof. F. H. Snow, at Lawrence, Kans., who tells me that the young locusts are now common in the larva state at a point on the Kansas Pacific Railroad ten miles west of Lawrence. None were seen east of this point.

At Topeka, *spretus* was common along the railroad in the second and third larval stage. They had only eaten holes in the weeds about the houses. Heavy rains had killed the young.

May 31, at Brookville, winged *spretus* was not as common as other *Calopteni (differentialis?)*, but more common in the second and third larval stages, about farms especially. No *spretus* seen beyond this point on the railroad, but other grasshoppers were abundant.—[Notes by A. S. Packard, jr.

I am happy to say there have been no serious depredations so far as my observation has led. I have observed in many localities where millions of young locusts hatched since the recent hard and continuous rains have been washed out into the main streams and carried off. In many localities they have disappeared by some unknown cause. On the whole, the farmers have no reason for complaint yet.—[R. M. Spivey, Topeka, Kans., May 30, 1877.

The locusts are not very numerous in Allen County now. Somehow they have hatched very slowly, and disappeared very mysteriously to many of us. We have burned some on old grass and on scattered hay. Rolled a few. Domestic and wild fowls have devoured many.—[H. E. Van Deman, Geneva, Kans., May 30, 1877.

The grasshoppers are still hatching out in some localities, and in others there are none hatching yet. The places where they are hatching appear to be of a peculiar character, viz, where it has been sheltered on the south by hills, timber, or some thing of th t kind, and in places which were low and wet, and wholly or partly covered with water during the month of February. I have so far failed to hear of any very extensive damages having been done in this locality. One of our farmers who has suffered the most heavily has constructed a fine exterminator, something

similar to one described in your bulletins, and has so far succeeded in saving his corn crop, though it was of no avail in his wheat and oats, his wheat being already headed out. Some of our farmers are thinking that they will destroy all of our crops this year, and many others seem to think that they will do us but little damage this year. They appear to disappear very mysteriously after they are about a week or ten days old. Undoubtedly there are now here none of those that first hatched out.—[W. L. Lanter, Garnett, Kans., June 1, 1877.

The little grasshoppers have nearly all gone. No damage in this county, to speak of. The majority of eggs were destroyed by rain and frost.—[S. B. Abbott, Oswego, June 3, 1877.

All the grasshoppers here this year appear to be of a somewhat darker shade of color than the ones we had two years ago; they also seem to be a little longer in proportion to their weight than they were two years ago. They are doing us no material damage except in small localities. Even garden vegetables are generally unmolested, except once in a while we hear of a garden that has been slightly damaged by them. They do not appear to get to be more than ten days to two weeks old until they disappear, caused by some kind of a parasite so small that it cannot be seen by the naked eye. Most of our farmers are still in good cheer, and the ones who were most discouraged are growing lighter-hearted. We are and have been blessed with heavy rains, which have drowned a great many of the young 'hoppers. I am not aware that any one has attempted to fight them by fire or any other method than the one of which I spoke in my last. I have heard of no one who has been ditching to kill them. Father (J. H. Lanter) has just returned from a trip to the southeast portion of this State, and he says that they are not doing any more damage there than here. He reported one man in the northwest corner of Bourbon County who has been successfully fighting them with fire. He draws out two or three wagon-loads of straw, and then drives the young 'hoppers into it and sets fire to it. More anon.—[W. L. Lanter, Garnett, June 5, 1877.

From all parts of the county come the glad tidings that the grasshoppers are doing but little damage. They are disappearing nearly as fast as they hatch out. The crops are growing nicely, and if the season continues favorable an abundant harvest can surely be relied on.—[*Junction City Tribune*, June 7.

The grasshopper crop here has proven to be a failure. There is not one this year where there were a thousand two years ago. The damage they do us this year amounts to a mere nothing as compared with two years ago. There are none flying over and lighting here, and the few that hatched here are nearly all dead. The cause of their premature death is unknown to us.—[W. L. Lanter, Garnett, June 13, 1877.

Locusts flying north with a good breeze. They appear to fly in scattered swarms, not very thickly. They generally fly very high.—[R. Milliken, Emporia, Kans., Lyon County, June 14.

From 12 m. to 4 p. m. locusts were flying north by east, with a mild breeze. A pan resembling the Salina pan was used here, but the locusts were not sufficiently numerous to warrant its extensive use. It only differed from the Salina pan in having handles attached to the ends, and was carried by two men walking at the ends.—[A. N. Godfrey, Hartford, Lyon County, June 12, 1877.

They are now hatching by the car-load on the western borders of the county and throughout Brown and the counties west. Farmers are fighting them to their utmost, the materials used being chiefly tin pans and coal-oil. The issue is extremely doubtful. As a fair sample of the whole infested country, one instance will illustrate. Enoch Spaulding, living three miles west of White Cloud, has an eighty-acre pasture field. Last Friday they went to work catching young grasshoppers (just large enough to hop), and on that field they caught one hundred gallons of the insects, pressed and packed down. They filled twenty nail-kegs.—[*Troy Chief*, June 14, 1877.

We have not been plagued as yet with 'hoppers, although they have been hatching out for some time, but none seemed to grow large.—[George F. Smart, Dickinson, June 14, 1877.

At this writing all danger from our old enemies seems past. It is true they are thick in places, in the rank weeds and grain, but we are abundantly satisfied that not 2 per cent. of the insects hatched this spring are now alive. We have been greatly surprised at the number of birds, strangers to this State, which seem to have taken up their residence permanently with us. Robins are almost as common in this vicinity as in New York, and we notice with no little pleasure that a couple of pairs of bobolinks have gone to housekeeping in the blue-grass meadow on the College farm.—[Professor Shelton, *Industrialist*, June 16.

MANHATTAN, RILEY COUNTY, *June* 16.—The locusts here have done no damage since last report. Some are now in the pupa state, but none have yet acquired wings. A few winged locusts have descended from the passing swarms.

SOLOMON CITY, *June* 18.—Visited the wheat-fields of A. P. Collins and J. H. Baldwin, near this city. Found the locusts acquiring wings and leaving very rapidly.

SOLOMON VALLEY, FROM SOLOMON TO BELOIT, *June* 19.—Locusts flying rather thickly from 10 a. m. until noon. But few flying after noon. None of the crops have been seriously injured except by the floods.

BELOIT, MITCHELL COUNTY, *June* 20.—Locusts have been leaving for nearly a week. They are sparingly affected with the parasitic maggot, a few dead ones being found.—[A. N. Godfrey.

Yesterday I visited the country round about Chanute. Found the locusts very scarce and quite small. The eggs are not yet all hatched. Along a road in very sandy soil, about one mile south of the town, I found some eggs still good. Many of them have decayed in the ground. I will send a small box of these eggs by mail. This morning I waited some hours in Parsons, where I found the locusts casting their skins the last time and getting wings. A few could be seen flying at various heights above the earth. Between Parsons and this place I traveled on a freight-train, and had an excellent opportunity to make observations. In many places, the locusts were quite plenty; twice I observed people fighting them from corn-fields. Here (at Chetopa) they are very abundant and very variable in size; most of them have their wings. They began the last molt June 16. Many of them flew away yesterday. Although there are a great many locusts here, yet they are doing no harm to speak of. They feed mostly upon dog-fennel, ragweed, &c., and rarely are found in corn or wheat fields; some few gardens have been taken. Several persons who have tried the Paris-green mixture report that it works admirably.

The young locusts, which were so abundant when I visited this region before, have nearly all disappeared. People along the Neosho River say that during the late high waters immense numbers of them floated down the stream and perished. Many, also, were drowned upon the fields.—[George F. Gaumer, Chetopa, June 20, 1877.

I see no harm done as yet. Young 'hoppers are not very numerous in this neighborhood, and the crops have not suffered so far.—[H. M. Robertson, Claytonville, Brown County, June 20, 1877.

There has not been the damage done I anticipated some time ago. I have visited several points in the county, and only in a few isolated localities, and these quite limited, do I find them in sufficient quantities to be annoying. We may be said to be entirely out of danger.

The mysterious disappearance of the insects is the wonder of the people. I am told by persons every once in a while, "A few days ago there were thousands of the little insects; but when I went again scarcely one was to be seen." Such has been the experience of the people all season.—[Robert Milliken, Emporia, June 22, 1877.

They have not done $10 worth of damage in our county. The county was honeycombed with eggs; but they commenced hatching early, and continued to hatch for six or seven weeks, and would nearly all disappear as fast as hatched. At first the birds destroyed them by millions. Those that are left seem to be sickly and demoralized. I first noticed them rise and fly on the 20th of this month. There were enough eggs within a quarter of a mile of my place, if all had hatched and been healthy, to have swept the county, and I have not lost a penny's worth of vegetables or fruit by them. —[B. L. Kingsbury, Burlington, June 25, 1877.

The grasshoppers have about all disappeared from this locality; what few are left are about grown. They have not done much damage in this county. I think that $500 would fully cover all damages that have been done in this county, and probably less.—[W. L. Lanter, Garnett, July 3, 1877.

The 'hoppers were flying in the air in small quantities in May and June for a few days. None have lighted here at all.—[Dr. H. A. Ellis, Russell, July 3, 1877.

They have done no injury this year worthy of note in any portion of our county.—[Jas. Hanway, Lane, Franklin County, July 5, 1877.

They have eaten steadily in my grain-fields, doing most of the damage on the first 16 feet, but working more or less over the entire field. Damage less than was generally expected. In no case have they destroyed a fine crop. I think 10 per cent. will cover the loss throughout this section, and it certainly will in this section.—[Solomon Whitney, Manhattan, Riley County, July 7, 1877.

I think Labette County, Kansas, would have produced 600,000 bushels of wheat this season but for the locust last fall, and now will produce perhaps 300,000. They not only ate up many fields but prevented many from sowing. I had 70 acres ate all clean. Sowed about September 5 35 acres. Soon after they took about half, eating in from the outside.—[C. C. Perkins, Berket Mass, Kans., July 7, 1877.

Since my last report, when I stated that the swarms of locusts had gone over Alma, no more have been seen. The eggs hatched out in this vicinity at end of April, and did on same places damage. They are full grown now, and left from 2d to 9th of July,

generally starting at 11 o'clock a. m., flying slowly upwards, and going thence with upper wind, which has been in these days northeast by north. I should judge that one-tenth of the deposited eggs have been hatched out; could not find any that had died. The weather was not favorable for them, as there was more rain than generally.—[G. Zwanziger, Alma, July 10, 1877.

I am happy to be able to state that the locusts have not as yet put in an appearance, which is unusual, as we generally see them before this passing over; but I have little fear of them as long as it continues so wet. The native 'hoppers are quite plenty, and will doubtless work to some extent on the borders of wheat-fields.—[Eugene Palmer, Farland, McPherson County, Kansas, August 8, 1877.

As yet the locusts have failed to make an attack, although the air is full of them and has been for four days back; they are tolerably high and moving to the north; we had a heavy rain here on the 8th instant, which makes it favorable for us. Much wheat is already up.—[Eugene Palmer, Farland, McPherson County, Kansas, August 10, 1877.

Since last writing you we have had a visit from the grasshoppers, though not in such vast numbers as to do material damage, other than giving a very discouraging look to the prospect for corn. First noticed came in on a north wind, on Wednesday the 8th instant; at about 5 o'clock, the wind became quite variable and numbers came down. As soon as there was a north wind again they rose up and many left, but the wind has been so variable that as many or more have come in as have left us.—[J. P. Heaton, Belleville, Kansas, August 13, 1877.

What hatched here last spring failed to reach maturity, except a very few; they did me no damage the past year. In the month of September last I noticed two or three small swarms going south from north, but few came down or coupled or deposited any eggs. As I observed, those that came down soon disappeared, and I think we are entirely clear of them.—[H. F. Rice, Iola, November 15, 1877.

APPENDIX VI.

IOWA DATA FOR 1877.

Reports from Chickasaw, Delaware, Fayette, Black Hawk, Warren, Muscatine, and Keokuk Counties state that there is no danger from the 'hoppers within their borders.

Clay County.—The ground is filled with grasshopper eggs. The prairie has been left unburned this year, so that the 'hoppers might have a warm reception when they do begin to come out.

Humboldt County.—Not much damage is anticipated from the grasshoppers this year. The eggs have not hatched out yet, and when they do all hands will turn out to extirpate them.

Hamilton County.—'Hopper-eggs not out yet; but as the ground is full of them, when the warm weather comes we expect a swarm.

Guthrie County.—No apprehension of danger from grasshoppers exists. There are eggs enough in the ground, but we do not think they will hatch out.

Woodbury County.—February was so pleasant that a few grasshoppers came out, but generally the eggs did not appear fruitful.

Page County.—The cold weather has stopped the eggs from hatching. Such a small quantity hatched during warm days that it is hard to determine whether this cold weather would kill them. Freezing does not seem to kill them, as some were placed between two cakes of ice and frozen solid, and when thawed would come to life and begin to move off; hence, I believe, we can make every calculation of raising a wonderful crop of 'hoppers this season.

Crawford County.—The ground has a great many grasshopper-eggs in it, and we fear the small grain will be badly damaged this spring, and probably not over one-half as much wheat as usual will be sown. The prairie-grass is being saved to roast all we can of them when the proper time comes.

Harrison County.—The hatching of grasshopper-eggs has not commenced. The season was very moderate all through February, but not quite warm enough to melt the ground any depth or hatch out the 'hoppers. The people seem very unanimous in trying to destroy them as soon as hatched, by machines and every available way.

Hancock County.—The 'hopper question agitates this county considerably at this time, and as it is the first time that they have deposited their eggs in this county, we hardly know how to operate against them. In the warm weather in February there were a few found hatched out on warm, gravelly knolls; there were some brought to this village and put in a glass jar, and some are alive yet. The eggs are in good condition generally, and very many of them. The prairie-grass was saved last fall, and we expect to burn a good many of them this spring. There is a general desire to cooperate and make a big fight for our crops and gardens.—[*Prairie Farmer*, April 6, 1877.

ALBIA, *April* 12.—There are no grasshoppers in this part of the country. The spring has been very backward. Some spring-wheat has been sown.

CHARITON, *April* 12.—No grasshoppers in this vicinity nearer than one hundred and fifty miles or more. Spring is quite backward, too much so to tell about crop prospects yet. Late spring will doubtless prevent the sowing of much small grain.

BLOOMFIELD, *April* 12.—The spring here is wet, cold, and backward. Farmers have not yet commenced work. Cannot say much in regard to crop prospects. Scarcely any wheat is raised in this county. Grass will probably get a good start. There never have been any grasshoppers in this county in sufficient numbers to give any special annoyance. We apprehend no trouble from them this year.

CEDAR RAPIDS, *April* 12.—Spring is backward; it is impossible now to tell the prospects; farmers hard at work; much seeding done; no fear of 'hoppers here.

MARSHALLTOWN, *April* 12.—No grasshoppers in this section.

NEW SHARON, *April* 12.—We never have had any grasshoppers here, therefore we do not look for them. It is too soon to give you information in regard to crops. Farmers are very busy sowing their wheat and oats.

DAVENPORT, *April* 12.—No grasshoppers in this vicinity; farmers are putting in crops as rapidly as possible; weather pleasant.

CLARINDA, PAGE COUNTY, *April* 13.—Farmers are busy and hopeful. Grasshoppers have not made their appearance in formidable numbers, although we have had favorable

weather for hatching. Farmers are not sowing large crops of small grain, depending mostly on corn and stock.

LENOX, *April* 13.—The prospects of crops are good; farmers will get their corn in earlier this spring by three weeks than they have been able to do in the last three years. No signs of grasshoppers as yet, and the general opinion is that the warm weather in February and the cold in March have destroyed a majority of the eggs.

MASON CITY, *April* 13.—There is not the slightest reason for believing there will be any grasshoppers in this vicinity, and the prospect for a good crop was never better.

MANCHESTER, *April* 13.—We see no reason for a failure in crops at present. Farmers are now putting in their wheat. Our spring is a little more backward than usual. We have no grasshoppers here.

IOWA CITY, *April* 13.—Concerning the 'hoppers, would say that they have not appeared in this section whatever. The prospects for the coming season, as far as crops are concerned, are good.

ALLERTON, *April* 13.—There are no grasshoppers here, and the prospects for crops in this vicinity are tolerably good.

VILLISCA, *April* 13.—We have learned but little yet about the intentions of the grasshoppers. The weather has been so cold and spring so backward that they have not begun to hatch out yet. Farmers apprehend but little danger from those that hatch here, as they will be off before the crops get along far enough for them to damage, though everybody more or less expects trouble from them.

MISSOURI VALLEY, *April* 13.—Our section is full of grasshopper-eggs, which are just beginning to hatch. We cannot yet tell what damage they may do. Our farmers are putting in very little small grain, but will put in as much corn as usual, and we hope the 'hoppers will leave early enough, so that they will do us but little damage, as was the case three years ago, when they hatched here, leaving before the corn was up.

DUNLAP, *April* 13.—The prospect is good for a large crop of corn; there is but little small grain growing, on account of the grasshopper scare, but we do not apprehend that the grasshoppers will do any damage to the crops in this section; they have not hatched out yet.

KELLOGG, *April* 14.—There are no grasshoppers in this section of the country never were; have been in the western counties of this State. The crop prospects are very favorable so far; do not think we will be troubled with them this season; at least hope not.

STANTON, *April* 14.—The grasshoppers are now hatching; although no damage has been done, there is much uneasiness among farmers.

HAMBURG, *April* 14.—We have the gravest apprehensions in regard to the grasshopper prospects. The earth in this section is literally filled with their eggs, and in favorable locations are only beginning to hatch. Farmers are sowing a little less than usual of small grain; their main reliance is for a half-matured corn-crop, planted after the fledged 'hoppers shall have flown. Using past experience as a criterion, we see nothing better to hope for.

CORNING, *April* 14.—No grasshoppers have hatched out yet, though there are plenty of eggs. A large wheat-crop has been sowed and coming up finely. Farmers are a little uneasy about the 'hoppers.

SIOUX CITY, *April* 14.—Grasshoppers are hatching out in most parts tributary to Sioux City, and we are apprehensive that there will be 'hoppers plenty in all the following States: West Iowa, Minnesota, Nebraska, Kansas, and Dakota Territory. They may do a great deal of damage, and they may not. There is just one way for us to do, and that is to shape our course so that we can stand a good crop of 'hoppers, and if they do not come we will be in luck.

DUBUQUE, *April* 14.—No grasshoppers nearer to Dubuque than 125 to 150 miles to date.

CLINTON, *April* 14.—Crop prospects are good as usual at this season of the year. No grasshoppers in this section.

AFTON, *April* 14.—There were no grasshoppers in this county last year, and no signs of any here this year so far. They may come from the West, as we hear that they are hatching in the west part of the State. The prospects of a crop here are good.

BEDFORD, *April* 16.—We do not hear anything in our immediate vicinity of 'hoppers. There were a great many eggs deposited on three sides of our town from ten to twelve miles; none nearer. The warm weather in February hatched a great many of them out. There are none now.

COUNCIL BLUFFS, *April* 17.—Grasshoppers are hatching out here, but are too small to do any damage yet. Farmers are putting in the usual acreage.

BELDEN, *April* 19.—There are no grasshoppers in this vicinity. Crops are good and the weather favorable.

DES MOINES, *April* 20.—Dismal reports come here from the 'hopper-infested counties in this State. Last week nearly a score of families left Pocahontas County from dire necessity to procure bread to eat. Seed is scarce, and they have had no money to purchase with. The season is now too far advanced to secure a crop if they could get seed, and, with the almost certain failure to raise anything except as food for grass-

hoppers, they prefer to leave. As many more farmers were prepared to leave this week. As this is a sparsely populated county, the depopulation will be plainly noticeable. Representative Oliver has done much to help these people by sending all the seed grain he could get hold of at the "posie" department at Washington.

MALVERN, *April* 25.—The crop prospect here is fine, and farmers are forward with spring work. The ground is in fine order, and some corn has been planted. Grasshoppers are hatching out freely, but seem to be in spots, and have already ravaged some wheat and oat fields in some localities. It is not believed the damage will be general.

MURRAY, *April* 26.—We have no grasshoppers here. No eggs were deposited. We are having too much wet weather, with prospect of a late spring. Thirty or forty miles west of here there are 'hoppers in abundance, though the late rains have rotted many eggs.—[*From the Saint Louis Globe-Democrat.*

MARSHALLTOWN, *May* 2.—Wheat is looking nicely. Good prospects for corn, but very little planted. Small fruit is nearly all killed, except strawberries. Grasshoppers have not visited us, but a few have been brought here to experiment on, which, after being frozen up forty hours in the storm of Saturday and Sunday, were able to sing, "We stood the storm; it was not long," upon being exposed to the sun a short time.

SIOUX CITY, WOODBURY COUNTY, *May* 2.—Reports about grasshoppers from the surrounding country are conflicting. It appears from the best information that in some places they are plenty and have damaged young grain and vegetables. Other reports show that they are fast disappearing on account of the wet weather and the parasites. All crops are unusually promising. The area of wheat sown is probably less than last year.

ONAWA, HARRISON COUNTY, *May* 2.—The late storms did not injure 'hoppers materially. The blackbirds are here by the million, and are destroying them rapidly. Very little wheat was sown. Farmers feel confident that corn, which is the staple, will not be injured to any extent. A very large acreage of corn is being planted. The farmers are sanguine of good crops.

DES MOINES, POLK COUNTY, *May* 2.—The facts here in regard to grasshoppers are meager. The late snow-storm has not interfered with them materially. After thawing they come out lively. None within forty miles of here. The late freeze has blasted all small fruit except grapes. Large fruit will also suffer some.

BOONE, BOONE COUNTY, *May* 2.—Grasshoppers are remarkably scarce in this locality, but in Western Iowa, along the line of the Northwestern Railway, they are reported very numerous, and it is said the late snow-storm had no effect in thinning their number. Will make an effort to have complete and reliable report of crops, &c., for Saturday or Sunday's issue.

CLARINDA, PAGE COUNTY, *May* 2.—Grasshoppers are scarce in this section, although millions of eggs were deposited. Up to this time but few of the eggs have hatched. Farmers are confident, and the prospect for good crops is favorable, although the wet weather of the last few days caused serious delay.

CRESTON, UNION COUNTY, *May* 2.—The grasshoppers in this section were mostly killed by the recent cold snap and no damage is feared from them. Farmers are hopeful of good crops, although the recent storm will delay corn-planting. Small grain looks well.

RED OAK, MONTGOMERY COUNTY, *May* 2.—The recent cold rains and snow storm have proven very disastrous to the 'hopper family in this section. Doubtless millions have been destroyed. It is believed there are not enough left to damage crops to any great extent. Farmers are being somewhat delayed on account of the recent heavy rains, but are jubilant over present prospects for a heavy harvest of all kinds of grain.—[*Omaha Herald.*

LE MARS, PLYMOUTH COUNTY, *May* 2.—There are no grasshoppers in this section, and the prospect for good crops was never better. Weather fine.

STORM LAKE, BUENA VISTA COUNTY, *May* 2.—Storm not severe enough to destroy young grasshoppers, but they are too few to do any damage. Crops never looked better.

CARROLL, CARROLL COUNTY, *May* 2.—The storm has killed at least two-thirds of the young grasshoppers. Cold rain now falling will dispose of the balance. Crop-prospects fine. Wheat all in and well up. Large amount of corn planted.—[*Western Farm Journal.*

Since my last communication things present a more hopeful appearance. The unusual wet spring has, indeed, been our salvation. Thousands of bushels of the 'hoppers have been killed by becoming benumbed by the cold, drenching storms and being drowned in pools and ditches. The bare ploughed fields and the hard, smooth roads are covered with their dead carcasses, and although this destruction has undoubtedly not been so complete in the bluffs and on the high rolling grounds as upon the bottom grounds, yet I can safely say that of all the eggs that have hatched (and nearly all have) much the greater part have been destroyed. Still, although the outlook is

brighter, there will be much damage done. Many fields of wheat and oats and corn have been totally destroyed. Some damage has been done to young fruit trees, and gardens as a general thing have been eaten up.—[A. H. Gleason, Little Sioux, May 3, 1877.

GREENVILLE COUNTY, *May* 9.—Grasshoppers are hatching by the million, and have commenced to destroy the small grain. I think that not a tenth of the eggs are yet hatched. The cold weather of March did not kill them, as we had hoped. They will take our crop unless the farmers can destroy them. We think we can kill them by burning the prairie. Some one has invented a trap to catch them.

EMMET COUNTY, *May* 9.—On the flat clay subsoil lands the grasshopper eggs are mostly destroyed; on gravel and dry ridges they are in good condition, but are being destroyed by birds and the little red bug. Egg-cells that contained eight eggs, only two of them were sound, and they appear to be quite tender, and die when exposed to cold.

CARROLL COUNTY, *May* 9.—In some of our grain fields the grasshoppers have commenced their operations, and, although most of the eggs are unhatched, still they seem in a healthy condition, but it is reported in the northern part of the county large amounts of the eggs are damaged and will not hatch.

ADAIR COUNTY, *May* 9.—The grasshopper eggs have not hatched here yet. We have had cold weather with snow the last month, and, we trust, when the weather comes warm, we shall know the whole story, and find the eggs dead.

HAMILTON COUNTY, *May* 9.—The 'hopper eggs have commenced hatching along the river, but I have seen none as yet on the prairie. It is impossible to determine at this time to what extent the eggs were destroyed in March. I think only such as were picked up by the birds.

HANCOCK COUNTY, *May* 9.—Farmers are nearly done sowing. The prospect for a crop would be very bright were it not for the grasshoppers. It is generally thought the eggs will not hatch, as the appearance of the eggs is the same as in February. If there is any life in them we hope the recent storm has killed them.

HUMBOLDT COUNTY, *May* 9.—The grasshoppers have commenced hatching. In warm, sheltered places plenty of them can be found. Many of the eggs will not hatch, but from the great amount in the ground they will not be missed.

CRAWFORD COUNTY, *May* 9.—The grasshopper eggs have hatched in great numbers on last year's breaking in sandy soil and on the roadside. They have commenced to eat the small grain.

BLACK HAWK COUNTY, *May* 9.—No sign of grasshoppers as yet. The last few days of April were cold, with a heavy snow storm; we hope it has finished the 'hopper.

ADAMS COUNTY, *May* 9.—What few grasshoppers' eggs were laid have nearly all died. There will be no trouble here from the present grasshopper crop.—*Chicago Tribune.*

The young have hatched in great numbers, but a great many have been destroyed by the unusually wet spring. Still, enough still remain as alive or to be hatched to do great damage. Indeed, even now whole fields of wheat and oats have been totally destroyed; and corn, which is now just coming up, is being attacked.—[A. H. Gleason, Little Sioux, Harrison County, Iowa, May 21, 1877.

But my opinion, after riding to and fro over patches of a dozen square miles, is that around the timber and along the warm lands there have been enough hatched to do very serious injury, especially if warm, dry weather comes for the next month.—[J. E. Todd, Tabor, Tremont County, Iowa, May 24, 1877.

I have received your circulars and bulletins, for which you have my thanks. A few grasshoppers hatched in this vicinity during the warm days in February, and people were very hopeful that the eggs would be so *quickened* that they would be destroyed. Probably large numbers were, as they seem just now, for the most part, to be hatching on the dry, sandy knolls or knobs. For three or four weeks past they have been slowly hatching in such sandy spots, and along the roadsides where grading has left exposures of solid clay; but until within a few days they have not seemed to be growing or threatening much damage. But on Saturday last Mr. J. D. Sells, a friend of mine, who lives on the line between this county and Wright, six or eight miles northwest of here, was in town, telling that he had had twenty-six acres of wheat utterly ruined by the insects. Some stories, though not placing the damage so high, had been told by other farmers; but, as this is the season of "croaking," little attention had been given the matter. I therefore went out to his place on Sunday (yesterday), to see for myself. I found his story true in every respect. He had sown twenty-six acres of wheat on high and dry ground—prairie, broken last season. It came up finely and gave promise of a splendid crop, and was at least six or seven inches high when the grasshoppers began their work on it a few days ago; but they had eaten it all up except less than half an acre, and were closing in upon that very fast. A portion of the field he had already plowed and planted with corn, and is to-day at work to replow and plant the remainder. Not only had they eaten the wheat, roots and all, but there

were none of the soft, succulent weeds left. They had left their "chips" everywhere. The ground was as clear of vegetation as the surface of a brick-yard. After thus eating the bulk of the wheat the insects congregated on an adjoining piece of rolling prairie, near a skirt of brush, on which the grass had not been burned last autumn, no doubt for the purpose of living off the very tender young grass which was springing up. During a high wind Mr. Sells set fire to this dry grass and made a holocaust of them. He thinks he must have burned at least twenty bushels, as the ground was black with them.—[Charles Aldrich, Webster City, Iowa, May 27, 1877.

I find, by referring to my record of observations, that the grasshoppers came last year August 24, and continued to increase in numbers for some days following. Their coming was too late to do much damage to the crops. They deposited immense quantities of eggs through this section of the country, and the farmers were very apprehensive of the consequences, so that but little improvement in building is going on this year. The quantity of eggs in places, as found by actual count, was over 250 in a square inch. Others have estimated them as high as 35 bushels per acre. The nice beautiful weather of last fall hatched out some of the eggs, and I saw the little fellows hopping around just before cold weather set in for winter. This fine weather that hatched some probably partially developed many others which the cold of winter destroyed. The warm days of February and March developed, I think, the largest share of those the warm fall weather left undeveloped, and the freezing nights and cold storms of April destroyed them in immense quantities. They commenced hatching out April 14, and have continued to up to this. In some fields protected from sudden changes of weather, as near timber, they are hatched in numbers sufficient to materially injure the crops; and where the fall plowing gave a favorable place to deposit the eggs in the greatest numbers, like that where the estimate was 35 bushels per acre, in such places, even if one in a thousand hatched, there would then be enough to destroy the crop in that locality. While plowing my corn ground, twelve acres, I did not see one on it. On my timothy grass not any were hatched. I have a blue-grass pasture. Where the eggs were deposited there are some, and they may injure it some, but not enough to materially affect the use as a pasture. They will soon commence traveling or hopping for a change of feed, and may then injure our corn and grain. Hens in and about our dwelling scratch up and eat the eggs as well as eat the insects. No powder or liquid has been used to protect plants that has come to my knowledge. Harrowing the ground after the eggs are deposited in the fall I think will be the most effective. I think two good harrowings, a few days apart, would destroy nearly every egg. Early plowing is good; ditching has been tried by one man and destroyed them in immense quantities. Traps of various constructions are used, and will do some good.—[J. F. Sanborn, Tabor, Fremont County, Iowa, May 28, 1877.

On 18th August, 1876, a very large cloud of locusts passed over us here from a little west of north (the day was bright), a small portion of which alighted in this and adjoining counties. Our small grain was all husbanded except a little late flax and our corn. They destroyed the flax, and we estimated the injury to the corn crop at about 10 per cent. They stopped with us from two to three weeks and left their brood. After depositing the egg they went out of sight. I think they died; large quantities of dead ones were scattered all over. Raw prairie that was broke last summer appeared to be a good bed for eggs, and also the flax ground. In these places both ditching and deep plowing and rolling were resorted to with good results. The first we saw of the young 'hoppers here was on 24th April, on a side hill facing the south. After that, it came very cold and wet weather, which we supposed kept back the hatching. About 10th May they commenced to come out in lots upon our wheat and barley fields. We are using the iron pan and cloth saturated with *kerosene*, and are killing them in bushels. I have no doubt but we shall manage to save our crops. Our pan cost only $1.40.—[Andrew Barr, Carroll County, May 28.

It is the opinion of farmers generally that the grasshoppers are dying rapidly. They are very thick yet, though not doing as much damage as ten days ago. Sod grain has been entirely taken, and on fields contiguous to last year's breaking the small grain is more or less injured, wheat more than oats. There are many large fields of small grain that seem to be not eaten at all, and look finely. As the corn comes up they eat it; some farmers continue planting—are using kerosene catchers.—[Roma W. Woods, O'Brien County, Iowa, May 28, 1877.

Locusts are growing slowly; many have reached the third stage, while more are still in the first. In many parts they are doing some injury to gardens and corn; also meadows and wheat fields. They seem more plentiful in the timber. It may be, however, that there they trouble the crops more because other vegetation does not suit them so well.—[J. E. Todd, Tabor, Fremont County, Iowa, June 2, 1877.

The grasshoppers have been and are still hatching out in large numbers; their eggs being spoiled proves to be a mistake; at least a large per cent. must have been hatched.—[H. C. McCoy, Algona, June 3, 1877.

During the past week we have made diligent inquiry in regard to the rumors of

the destruction of the growing crops by the grasshoppers in this section. The opinion at which we arrive is, that in limited portions, where the soil has been favorable to the preservation of the eggs, they are sweeping everything before them. A few days ago we visited Mr. J. D. Sells, who resides seven or eight miles north of town, and a part of whose farm is in Wright and a part in this county. He sowed a field of 26 acres with wheat, which came up and grew very finely. Ten or twelve days ago it was deemed far better than the average, and gave promise of an abundant crop. But the grasshoppers began hatching and eating, and when we saw the field three days ago the grain was entirely exterminated, with the exception of less than half an acre growing on wet ground. Not only had the insects devoured the blades and stalks, but they had eaten up even the roots and all the tender, succulent weeds. The ground was as free from vegetation as a brick-yard. After clearing off the field, the insects emigrated to a tract of prairie adjoining, upon which the grass had not been burned last fall, where they were "going for" the tender grass which was springing up. Mr. Sells set fire to the dead grass when the wind was high, and it was burned over in a very few minutes. He is of the opinion that he destroyed at least 20 bushels of 'hoppers by this one effort. The field he is now plowing up for the purpose of planting it with corn. This tract is high and rolling, and the soil is dry and sandy. In a neighboring field about six acres of wheat on similar land has also been eaten up. But this, we believe, is the extent of the damage in this vicinity. There were great clouds of smoke rolling over the prairie off to the southwest, where we presume other farmers were giving the insects the "heroic" treatment. We do not believe that there is to be very general or wide spread destruction of crops; but we shall be greatly mistaken if many of our farmers do not meet with losses very similar to that of Mr. Sells. The insects were still hatching on this land, while some of them were fully three-fourths of an inch in length.—[*Hamilton Freeman*, Webster City, June 6.

A few 'hoppers are still hatching, but the numbers are small. The wheat is getting rather tall for catching them now, but a great many bushels have been killed around here. About ten days ago I saw a patch of last summer's breaking, fifteen acres, which was seeded with barley, on which about eight bushels had been killed, and there were more there yet, but the owner was determined to continue with the sheet-iron pan until all were destroyed, to keep them from his wheat, and I am certain he would manage it. As yet very little damage has been done to the crop, and we have seen no full-grown ones.—[Andrew Barr, Carroll County, June 16.

All efforts to reduce them by machines seem of no avail. It is estimated in Cherokee County that one thousand bushels have been destroyed, but still the crops are about gone up; their wings have started, and unless they soon leave, the crops will be an entire failure. All that have been destroyed cannot be missed.—[W. Tucker, Chickasaw, June 18.

POTTAWATTAMIE COUNTY, *June* 23.—Very rainy here for last eleven weeks. Wheat and oats look very promising. Corn a poor stand and backward. Not much hog cholera this summer. 'Hoppers are damaging the crops on many farms and cleaning out many gardens.

CHEROKEE COUNTY, *June* 26.—Corn is rather backward, and some has had to be replanted; many fields where the wheat was eaten by grasshoppers have been planted in corn. Wheat and oats look fair where they have not been eaten up by grasshoppers. They are still here and at work, and some are afraid they will take a large share of the crops before they leave.—[*Western Rural*.

My locality is two or three counties east of where these pests have been operating. Last fall a few eggs were deposited in the northwest corner of our county (Story), and were hatched this season, but not enough to do any damage. These are all ever known in this county, except in the summer and fall of 1866.—[E. G. Day, Nevada, June 28.

CLAY COUNTY, *July* 4.—Corn good generally. Spring-wheat good where 'hoppers have not destroyed it. Oats very good. 'Hoppers nearly gone.

HUMBOLDT COUNTY, *July* 10.—Corn doing finely. Spring-wheat good. 'Hoppers have damaged a few pieces badly.—[*Western Rural*.

During the season I have observed locusts here in some parts in considerable numbers, but in no case have they been numerous enough to do any damage. No swarms have at any time within twelve or fifteen years come nearer to us than Des Moines, Iowa.—[F. M. Witter, Muscatine, November 1, 1877.

In 1868, according to the second biennial report of the Agricultural College, "grasshoppers were abundant at Ames." I did not see them, as I was not then a resident of Iowa. In all probability they were the Rocky Mountain locust. In 1873 and 1874 a few specimens of *C. spretus* were picked up on the college grounds. Considerably more were found in 1875, while in 1876 they were abundant. In the fall of the last-named year they laid many eggs in Central Iowa. In the spring of 1877 they hatched,

but for some reason not known to me (nor any one else hereabouts) they did no amount to much. No eggs were laid in 1877. Now, Ames is probably about as far eas as these locusts have passed in Iowa. Hence observations here have a peculiar valu in certain respects, while in others they are not so valuable. In 1875 I sent out many inquiries as to locust devastations, but failed to receive replies in most cases. I give results from four counties:

Monona County.—Invasion from the south on the 24th and 25th of June; mostly flying toward the northwest. But little damage done. Parasites numerous.

Pottawattamie County.—Invasion June 20; present about two weeks; flight some times from south and sometimes from northeast. Destroyed one-fifth of crops. Red mites on the locusts.

Fremont County.—Invasion about June 10; came from southwest and northwest flight continued for fifteen days. Then they left, going west and northwest. Injury to crops: Corn, one-fourth; barley, one-half; oats and wheat slight; beans, onions cabbages, cauliflower, beets, all gone.

Decatur County.—Some passed over, and a few parasitized ones fell, but no damage done.

In 1876 I also sent out inquiries. If you will turn to page 63 of Riley's last (ninth) report you will find the results tabulated. It will save both your and my time to take the matter from that report. In 1877 the young insects throughout the State did but little damage, and I know of no case in which eggs were laid in the fall of that year (1877). I regret that I am unable to give more exact data, but trust that what I have given may not be altogether worthless.—[Prof. C. E. Bessey, Ames.

APPENDIX VII.

COLORADO DATA FOR 1877.

SPECIAL REPORT FROM WILLIAM HOLLY, DEL NORTE.

Prof. C. V. RILEY, *Chief United States Entomological Commission:*

SIR: I have the honor to state that, in obedience to your instructions, I have visited personally most of the country lying south of an east and west line drawn through Colorado Springs, El Paso County, Colorado. My investigations under your letter of instructions were confined to a few days in May, the month of June, and part of July, 1877. I had previously, during the summer of 1876 and spring of 1877, passed over most of Southern and Southwestern Colorado, and having made notes of the ravages of the grasshopper for newspaper correspondence, I am able to speak from personal knowledge of investigations and researches prior to the date of May 20, 1877.

I started from Del Norte the first week in June, passing down the Rio Grande Valley (crossing the San Luis Park from west to east), to Fort Garland. The valley is devoted to agriculture and stock-growing, and most of the bottom lands are fenced. The grasshoppers have done but little injury in past years and none during the present season. Ute Valley, extending from the Rio Grande to the Sangre de Christo Range, a beautiful cultivated section, has been singularly free. Crossing the Sangre de Christo Range at the pass of that name, the first point is La Veta, the principal place in Huerfano County, and at the head of the Cuchoras Valley, one of the finest in Southern Colorado. In previous years great ravages have been committed in this valley and along the base of the range to the Arkansas. The Cuchoras Valley is principally inhabited by Mexicans, who use no precautions for preventing hatching, growth, or destruction, except acequias for irrigation. Along the eastern base of the Sangre de Christo a crop of grasshoppers which hatched in the latter part of April and early part of May were destroyed by severe rains followed by sharp frosts. The eggs for this crop were deposited by locusts late in the fall of 1876, when the ground was warm and almost bare of vegetation. The winter was open and mild and the spring early and hot, causing a premature hatching. The young appeared in immense numbers, but disappeared after the rains and frost spoken of. A second crop appeared and were active during my visit here in June, but in small numbers, and were generally found attacked by the Rocky Mountain grasshopper parasite. But little damage has been done in this county the present season.

I proceeded to Colorado Springs by rail, and after ascertaining that I was too late to investigate the early and too soon for the later or midsummer crop, I made very complete arrangements to have thorough reports made in readiness for your coming later in the season.

At Pueblo similar arrangements were made, as it was almost impossible to see farmers and stock-men on account of their absence at the annual round-ups.

I had previously made an extended trip through the Arkansas Valley from near Grenada to Cañon City. In 1876 the valley was visited by several swarms of grasshoppers, the last depositing vast quantities of eggs, which, at the time of my trip, March 12 to 20, 1877, were just beginning to hatch. There have been no artificial means used in this valley for prevention or destruction, and the plains have afforded excellent hatching-grounds. In past years Fremont, Pueblo, and Custer Counties have suffered very considerably.

I returned to Del Norte and passed up the Rio Grande Valley as far as farms extended, and crossed the range to Lake City. In previous years, from 1872 to 1876, this section has been periodically visited. Last year the upper valley of the Rio Grande suffered severely. The grasshoppers came from the northwest, across the range, making long flights, and swooping down in immense numbers, destroying every living thing, and attacking the cottonwood and willows. This season they hatched in small numbers in the valley of the Francisco, Pinos, Cebolla, and elevated exposed portions of the range. The prevailing direction of travel has been both east and west. Finding it difficult to travel with the conveyance I had, I returned to Del Norte and procured a saddle-horse, crossing the San Luis Park three times on my way to Park County. In 1876 Saguache County suffered from two different swarms, and this season grasshoppers

hatched in the latter part of May. The valley of the Saguache River is in a high state of cultivation, and all small grains and vegetables were eaten.

The grasshoppers of 1877 seemed to be weak, and have done but little damage. The direction of flight in July, 1876, was northeast, across the Saguache Mountains, to Lake County.

The San Luis Park comprises Saguache, Conejos, Costilla, and part of Rio Grande Counties. It is two hundred and ten miles from north to south and ninety miles at its widest from east to west. The park is surrounded by high ranges of mountains on every side. A glance at the map will show the Sangre de Christo and Raton on the east, Saguache on the north and northwest, Sierra Madre on the west and southwest. The upper portion is fertile and cultivated. The numerous valleys putting into it and the "Vegas" are generally taken up. Vast herds of cattle, horses, and sheep find pasturage; it has an average altitude of 7,500 feet; the soil is loam, sand, gravel, and alkali plains. It is most evident that it is the hatching place of the late grasshoppers, which find but little to feed upon except grass, and as soon as able leave this section for the valleys. The prevailing winds are westerly, blowing with great violence in the afternoon. Thus, naturally, the insects fly before the wind in the afternoon; in the forenoon they take a northerly and southerly direction. The parasite was not noticed until last summer (1876). During the present season its presence has been detected in almost every section where I have been.

In Lake County is an extensive section of cultivated land, lying along the main Arkansas. For four years the ranchmen have been "eaten out of house and home by the 'hoppers." In 1876 strong hopes were entertained that they would be exempted from the dreaded scourge, but in July and first weeks of August vast swarms came from the southwest in such numbers as precluded any attempt to prevent their ravages. Every green thing was eaten except pease (a portion of the crop had been harvested). The insects remained about fifteen days, and passed off to the east. The adjoining county of Park suffered considerably, especially the pasturage.

Very few grasshoppers hatched in Lake County the present season, the early crop dying similarly to those in Huerfano County, and about the same time.

Park County comprises a vast extent of grazing land and but little cultivated; it embraces the famous South Park, which has an altitude of 8,000 feet. Grasshoppers hatched in the eastern portion in March and disappeared. During my trip another crop were hatching, which has done but little damage thus far. This county is also a breeding-place in its extensive sandy plains, and furnishes the late recruits to destroy the valley products.

Crossing the dividing range between Lake and Gunnison Counties, at Cottonwood Pass, I found crops in the Gunnison Valley in a fair state of forwardness; a few grasshoppers had made their appearance. This promising county has been recently settled, within two years, and there is but little to report as to past experience. The adjoining county on the north summit has more direct connections with Northern Colorado, has been longer settled, and has suffered considerably. I can only speak from reports.

Passing down the valley of the Gunnison, miners, prospecters, and hunters informed me that vast swams had followed the course of that stream in a northwesterly direction; that in some seasons the herbage was completely destroyed. These swarms had evidently hatched in the vast plains of Western Utah.

The counties of Hinsdale, Ouray, San Juan, and La Plata are principally devoted to mining, although in the valleys of the numerous streams on the western slope are many fine bodies of arable land. The Utes still hold possession of a large portion of Southwestern Colorado, which prevents improvement by whites.

In the valleys of the Rio San Miguel and Rio Dolores, grasshoppers had not commenced hatching in June, but eggs had been deposited. These streams are in Gunnison County.

In the neighborhood of Parrott City, La Plata County, are extensive cattle ranges, and the country is rapidly settling up.

The valley of the San Juan River, both in Colorado and New Mexico, as far as the boundary-line of Utah, suffered very little in 1876, and the early crop of 'hoppers in 1877 disappeared without doing material injury.

Adjacent portions of New Mexico have been injured very little. The president of the New Mexican Stock and Agricultural Association informed me that no trouble was experienced by his colony (in Colfax County) in 1876, and up to June 15 were entirely free, while on the opposite side of the mountains the Taos Valley had been swept clear.

In all this vast extent of territory there are absolutely no means of preventing hatching or destruction either of young or old insects. The extensive plains—many of a sandy, barren nature—afford the best hatching-places that could be devised.

The young are hatched in these sections in July, August, and September, and take flight as soon as able for regions where subsistence can be easily obtained. In their course they cross the highest ranges of mountains; taking advantage of the strong westerly winds which prevail. Flying requires little exertion. Until some means shall

be devised to destroy the young in their hatching-ground, the locusts hatched in midsummer in these altitudes must ever be a terror to the husbandman of the valleys.

I returned from the San Juan Valley by the way of Conejos and Costilla Counties. These extensive sections are principally devoted to pasturage, and have not been much injured. Late crops have uniformly been cut off, however.

My observations have confirmed my previous statement to you, that investigations would be more profitable later in the season. The attention of the people has not heretofore been called to the advantage of scientific researches, but with the personal explanations given and the extensive distribution of printed matter, a desire to assist has been expressed, which will be manifested during the season, I presume.

I shall take pleasure in collecting statements and facts during the remainder of the season, as my duties as a correspondent take me into the different portions of the elevated plateau of the Rocky Mountain region.

Respectfully,

W. HOLLY.

DEL NORTE, *July*, 1877.

DUDLEY, *May* 5.—There are no grain ranches within fifty-six miles of here and too much snow for grasshoppers. Eight inches of snow fell last night, and it is still snowing.

MORRISON, *May* 5.—As far as I can ascertain, there will be from 25 to 30 per cent. more wheat sown in this vicinity this year than last. It is the opinion of the ranchmen that many of the grasshoppers have been destroyed by recent storms, but this cannot be relied upon.

FAIR PLAY, *May* 5.—No wheat is raised in Park County, and I am told that not over one hundred acres of wheat will be sown in Fremont County. The snow has destroyed some of the grasshoppers here, but in the wheat region they are very plenty and waiting patiently for grain to come to have a feast.

CENTRAL CITY, *May* 5.—I am informed that little or no wheat is sown near here. It is thought that the recent heavy and frequent rains have killed a great number of the 'hoppers.

GEORGETOWN, *May* 5.—No wheat ever sown in Clear Creek County. No grasshoppers to speak of.

IDAHO, *May* 5.—No wheat is seen around here, and not many grasshoppers have been seen here since the storms.—[*Rocky Mountain News.*

COLORADO SPRINGS, *May* 5.—The wheat is looking nicely, and ranchmen are looking forward to a good crop, provided it is not destroyed by the 'hoppers, upon which there is a variety of opinions. The general impression, however, is that the recent storms have destroyed a large quantity of them, and that the greater part of the damage will be done by the fliers rather than by those hatched in this vicinity.

BOULDER, *May* 5.—The general impression indicates confidence in a forthcoming abundant harvest. No apprehensions are entertained with regard to the young grasshoppers, and a feeling prevails that the late storms have aided the prospects of speedy growth, and at the same time retarded and in some measure destroyed the grasshoppers.

LONGMONT, *May* 5.—The grasshoppers have done no damage as yet. The recent storms have killed a good many, and no danger is anticipated from what is left, as they have plenty of water to fight them. All the ranchmen seem confident of a large crop.

CAÑON CITY, *May* 5.—Reports come from every direction that the recent storms have destroyed large numbers of the grasshoppers.—[*Colorado Farmer.*

EVANS, *May* 5.—In some places the grasshoppers have made their appearance, though as yet too small to do any damage to growing crops. The recent storms have had no effect in destroying them.

GREELEY, *May* 5.—Very few grasshoppers have hatched out as yet, but the storm has not materially affected those that were hatched. Some claim that the storm killed those that were about to hatch. Farmers are feeling well at the prospect of a good crop, and not much fear of 'hoppers. Everything looks prosperous and good in this valley.

HUGHES, *May* 5.—We find no grasshoppers yet, but have seen shells some four weeks ago. There is considerable white corn planted, as some farmers claim it to be grasshopper proof. Quite a quantity of pease are being sown. All grain was sown early, and there is some talk about the weather being too wet and cold.

GOLDEN, *May* 5.—In places where the grasshoppers had hatched and begun ravages the wet weather has nearly destroyed them. Some report eggs hatching on warm days, and the 'hoppers all right, but the general impression is that the wet season will check their depredations sufficient to prevent any serious damage.

PUEBLO, *May* 5.—But few grasshoppers have put in their appearance as yet, and the farmers generally do not apprehend any danger from them this year. The only section that reports grasshoppers in any considerable numbers is along the Greenhorn, where they are in great numbers. It was believed the recent heavy storms would

prove very destructive to them, but the reappearance of the sun and the warm weather seemed to impart renewed life in the seemingly dead 'hoppers, and made them as active as ever; but the farmers along the Greenhorn do not despair, and the acreage sown this year along that stream will fully equal that sown last year, and promises a good crop, if no damages are sustained from the 'hoppers.—[*Colorado Farmer.*

Bulletin No. 2 to hand. By way of information concerning the grasshoppers, will say from some cause the majority of those hatched early in the season have disappeared. A severe snow and rain storm of some days the latter part of April seemed to have such an effect upon the larvæ just ready to hatch that a large proportion never came forth. Large flocks of birds destroyed many. At this writing I hear of no damage being done to crops by them. Those that have escaped seemed demoralized and are scattered so the farmers apprehend no serious danger from them. I know of no extended efforts being made to destroy them. Crops are looking splendid; a heavy harvest is anticipated. We have not found the grasshoppers in sufficient numbers yet to experiment with our exterminator, so we have nothing more to report concerning it.—[J. S. Florry, Greeley, May 28, 1877.

From Mr. Joseph Coberly, who has just returned from Deadwood, we learn that from fifty miles north of Laramie City to Custer there are plenty of little 'hoppers. In Red Cañon, he said they are thicker than he ever saw them, literally covering the face of the earth. If these plagues are not killed by some natural causes, we may expect them down on us about the last of July. Thanks to the energy of our farmers and their early planting, most of the crops will be out of the way.—[*Colorado Farmer.*

During a residence of five years in Colorado I have repeatedly examined the species that do the most damage in Colorado, and have found it to be the single migratory species, *Caloptenus spretus*, although at certain points the *Œdipoda corallipes* is found in limited numbers; but I doubt whether it does much damage.

The grasshoppers which have done the most damage have been the migratory. The unfledged insect can do but very little harm, on account of the suddenness and lateness of our spring.

The hatching has been retarded this year for three weeks or a month, owing to the severe weather in early spring, and the consequence has been that hatching has been going on incessantly for the last month or six weeks, and I believe by the time hatching is completed most of the young will have perished. Instead of being very active, as I believe is the rule with the young, they are very weak, are quiet, and seem to show very little tendency to travel.

On the divide, near Colorado Springs, they are quite numerous, and seem to be traveling northeast, but perishing in large numbers owing to heavy rains. About Denver they are few in numbers, and farmers for miles around are rejoiced, thinking that Providence has in some way destroyed the eggs. We have had numerous heavy snowstorms, saturating and loosening up the ground, making it, to my idea, exceedingly unfavorable for the eggs. To show what effect moisture may have had on hatching of the eggs, Sergeant Barwick, of the Signal Service, shows an excess of moisture in Colorado (in inches) 4.11, from whence the excess appears to lessen somewhat in all directions except west. This excess is for the year 1877 and over the last five years. To this I believe to be due the grasshopper deficiency here, and the question is whether it will exert its influence east of here, so that the flying 'hoppers will also be few.—[Aug. Jacob, Denver, June 1, 1877.

DENVER, *June* 2.—Mr. J. S. Stanger, editor of Colorado Farmer, tells us that in 1876 there was a swarm of *spretus* three hundred miles long along the Kansas Pacific Railroad eastward of Denver. He thinks they came from a little east of north, and not from the west.

Mr. A. H. Arnett, says *spretus* hatched abundantly in the spring, but since died. Had hatched "within a week," namely, about May 25. He thinks they have all died from natural causes, *i. e.*, meteorological, as I understood him. I saw them about his farm on the plains, next to his wheat-fields, among the cactus, &c. He says the young are more feeble than ever before; that immense quantities of eggs were laid, but the *Anthomyiæ* (?) laid their eggs in the autumn in the holes and among the eggs laid by the locust—"would deposit a nit on the egg-sac of the locust, and hatch out in the spring and destroy the eggs."

There were very heavy cold rains early in May which must have destroyed the young, and there were light snows, four inches; more fell at Denver than at Cheyenne, and more at Greeley than at Denver. This combination of rains and cold weather is sufficient to account for the destruction of those young which escaped the ravages of the fly and other insects.

Mr. Ellwood, of Denver, tells me that the fly destroyed the locust-eggs and "many were laid barren, containing only a thin fluid [this may have been normal, the albumen and yolk], and millions became defective in the autumn, were weakened by a parasite fly [mite].

All the farmers agree, Mr. Arnett says, that they can take care of the young locusts.

They want to know when to expect the winged swarms. Grain was sowed a month earlier this year, so that everything except corn could be harvested by July 14–20.

Sergeant J. A. Barwick gave me full meteorological data about the snow and cold rains April 24–30. There was from December, 1876, to April, 1877, an enormous rainfall for Colorado, amounting to 8.17 inches, being an excess of 4.06 over the average for five years. So it is evident that the cold, rainy spring had the same effect on the young grasshoppers as in Kansas, Nebraska, &c.

June 3.—*Spretus* very abundant about Sloan's Lake, on the plains near the farms in second larval, third larval, and first and second pupal states; and many promised to become winged in about a week or ten days. The second pupæ were just molting their cast skins. The second larvæ were scarce; they were mostly in the third larval and first pupal stage. They were in schools scattered over the plain. Flies of two species were seen resting on the grounds about them. No mites to be seen.

GREELEY, *June* 4.—Mr. Joseph Ramsay, of Greeley, told me that he had just returned from Julesburg, and saw 7 miles east of Julesburg a high-flying swarm, one dropping now and then, and flying with the wind from the south in the afternoon. This was May 29. May 30 he saw them 17 miles west of Julesburg, at noon, flying high from the south; very numerous, as far as the eye could see. (He says that white Mexican corn does not suffer much as it is so early and is not eaten by the young.)

Mr. J. Max Clark says *spretus* hatched out by millions this spring, eggs having been laid by millions in the autumn, but 50 per cent. were killed by insects, a ground beetle larva, "mites," &c.; then came the cold and rain and snow, much more than at Denver April 24–27, which destroyed most of the remainder. In March the eggs were sound.

June 5.—I walked two miles up the railroad to Daniel Boyd's farm. Saw a school of larvæ in the third stage traveling southward. A small red wasp, a species of *Larrada* was busily engaged in stinging and killing the young. David Boyd says the first brood were destroyed, though the young locusts are numerous in townships northwest of Greeley.—[Notes made by A. S. Packard, jr.

Having been requested to communicate to you any information in regard to the locust or grasshopper, I take this opportunity to do so. The section of country in which I live, known as the South Park, is principally a dry plain; elevation from 8,000 to 9,000 feet. The locusts visited this section about the middle of September last, and the swarm was from four to six days in passing. There were a few that remained till cold weather. The direction of travel was from northeast to the southwest. They deposited their eggs over the entire country. The eggs commenced to hatch about the 20th of May, and are not all hatched at the present time. As this is not a farming country, there has been no effort made to destroy them; and if there are any insects that destroy either the eggs or young locusts I have been unable to discover them. I am convinced from observation and conversation with others that where the ground is kept thoroughly saturated with water for at least two days at a time, any time after the eggs are laid till time of hatching, that it very effectually destroys them.—[T. H. Robbins, Rocky Park County, June 12, 1877.

The grasshoppers during the past week have made a very successful clean-up on Ute Creek, but if they will let the farmers alone for the balance of the season they will try and raise a kind of a crop yet.

The grasshoppers have not troubled the farmers away from the mountains until within the past few days, but they are now, however, becoming numerous and troublesome.—[*Colorado Farmer*, June 14, 1877.

The locusts here have not commenced to fledge yet, though they will very soon. I have observed carefully, and none have been seen in the air here.—[W. D. Arnett, Morrison, June 18, 1877.

Your letter of date the 4th instant was received a few days ago, and in reply I would say that last summer I only noticed grasshoppers at this place on one occasion. This was on July 11, 1876, and they were brought up in a whirlwind which enveloped the Peak from the southeast and moved off to the northwest in a few minutes. They were carried up doubtless against their will, just as were a number of other insects and also considerable dust. I have never seen any eggs in the neighborhood of the summit, and think it entirely too cold for the 'hoppers to deposit them near here. Even at the lake lying southeast of the summit, at an elevation of 10,285 feet, I have seen no signs of the eggs.—[C. W. Hobbs, Pike's Peak, June 20, 1877.

I have nothing particularly interesting to communicate about the 'hoppers. They hatched out in immense quantities in the spring. Snow storms in April and May destroyed nearly all that were hatched. Some have hatched since, and in spots they are now quite plenty; appearance is not general throughout county; damage, so far, slight. No means has ever been tried of circumventing them here except with water—flooding crops, keeping water running in ditches around crops, &c., which is in a measure effective so long as they are small.—[W. B. Felton, Saguache, June 21, 1877.

Now as to the habits and range of the grasshopper in this part of Colorado. The grasshopper commonly so called—I mean the fellow that goes by millions in clouds that

cover the sun and that eat up the country in a day or two—the red-legged rascal that strikes terror into the hearts of the Kansas and Colorado farmers—does not, as far as my observations go, ever come into the San Juan basin in migratory swarms. At least for five years it has not, although immediately east of the mountains he has twice, within that period, eaten up all green things. The Utes say that they have never seen the 'hopper here in migratory swarms, by which I mean the country drained by the San Juan and its tributaries. Nevertheless they are abundant enough. As I write by the open window, I can hear thousands of them in the air and see them flitting about in the sunlight, white specks on a blue sky. In the lower valleys they have never done any harm to the crops, although they are numerous, except in the Spring, when hatching out in warm sandy places, the young 'hoppers at times will eat off the wheat and oats. In August and September I have seen thousands of females depositing their eggs near timber line; but never west of the divide of waters here have I observed them migratory or in swarms. Even when they are most abundant, especially about this time of year, and the air at times seems filled with them, they do not devour growing crops nor migrate in masses. Immediately east of here, however, it is quite otherwise. At Taos, they have, within three weeks past, as I am informed by Mexicans lately from that place, devoured every acre of corn and wheat and completely destroyed all crops. They appear especially numerous near timber line about this time of year, and I have often seen the surface of lakes literally covered with the thousands that have fallen into the water, until the trout could not be induced to look at one. I think it very likely that the swarms that appear in the valley of the Rio Grande may come from here, although I have no ocular proof of the fact; but however that is, it is certain they are very numerous here, breed here in vast numbers, but never do any damage to speak of. Possibly, however, when the country gets more thickly settled and larger areas of growing crops are offered to their voracious appetites, they may change their lines of march and favor us with a visit. [T. M. Trippe, Howardsville, August 3, 1877.

No 'hoppers have appeared in the valley or plain east of the mountains to deposit eggs since you were here. In South Park and San Luis Park many hatched at different times during the season, and some damage was done to crops; but, so far as I have heard, no eggs were deposited.—[James C. Shattuck, Denver, October 19, 1877.

WET MOUNTAIN VALLEY, *October* 31, 1877.—The hay-crop in some parts of Wet Mountain Valley was much better than was anticipated when we commenced cutting, the yield exceeding that of last year, while in other parts it was lighter than on previous years. There was but little farming done here the past summer, all seeming to fear the pests which have for a few years ravished our valley. I fancy it will be carried on quite extensively the coming year, as the grasshoppers did not deposit their eggs with us, and all feel confident they have bidden us a long good-bye.—[*Colorado Farmer*.

This section of country, Southwestern Colorado, filled up rapidly last year, and has now a large farming population. The Taos Valley, opening up in a fan-like manner from New Mexico, was devastated last summer, and many eggs were deposited. Incursions of grasshoppers are feared in the San Luis Park and adjacent sections from this direction.—[W. Holly, Animas City, January 5, 1878.

APPENDIX VIII.

NEBRASKA DATA FOR 1877.

[Being a journal kept by Prof. Samuel Aughey, of the University of Nebraska, as Special Assistant of the Commission.]

Kearney Junction, Sunday, March 25, 1877.—Very warm. Mean temperature this day, 70° F. In afternoon went to the bluffs north of town. Dug over several square feet to ascertain the number of locust eggs in the soil. On first foot found 317 eggs. On the second, which was on an elevation of loose soil, recently disturbed, found a great number of nests, which I counted, and, averaging them at twenty-eight to a nest, there were 21,700 to a square foot. This, however, was an exceptional number for this locality, as I found by further investigation. In the first spot examined, about 90 per cent. of the eggs were sound, and at the last about 80 per cent. The unsound ones were in the upper end of the nests, and seemed to have been segmented at some previous period, and then to have gone into semi-decomposition. A few entire nests in this condition of decay. The upper end of many nests seemed to be in a healthy state. Some nests that were well protected by old grass or weeds were apparently unaffected in any way. At one spot on the hill-side entirely bare of grass or weeds, I found a dozen of young locusts that had just come out of the shell. They were of a cream-color, and very lively. On the bottom found very few locust eggs.

March 26, 1877.—Left Kearney this morning at 8 o'clock, and crossed the Platte bridge south of town, and then passed through the Sand Hills, where I found few eggs of the locusts, and no locusts. At noon reached and took dinner at Mr. Nedlund's—section 30, township 6 north, range 17 west, Phelps County. Found some old breaking where the ground averaged about 211 eggs to the square foot. A few were hatched out, and a few were decayed. About 85 per cent. appeared to be good. Found further on in the afternoon some young live locusts on the banks of Turkey Creek, on and near new breaking. Made no estimate here of the number to the square foot. Of the eggs examined, about 90 per cent. appeared good. Reached Orleans at 7 p. m. Mean temperature this day, 68° F.

Orleans, March 27, 1877.—Orleans is located on the Republican River bottom—second terrace. Examined new breaking north of town and found 1,300 eggs to a square foot in one place, and elsewhere from 30 to 300. About 10 per cent. of the eggs were hatched out, and 10 per cent. were spoiled; interior yellow, and with an offensive odor. Went south of the Republican on bluffs where the soil is loose, and here on cultivated land in places found from 100 to 400 eggs to the square foot. On the uncultivated prairie found none. A few had been hatched out, some were segmented, and some already half formed, and some ready to come out. Probably not enough here to do much damage.

Watson, Harlan County, Nebraska, March 28, 1877.—This morning before breakfast examined the ground at some old breaking, and found from 50 to 200 eggs to the square fooot—some places none at all—none on the raw prairie, except around some old gopher hills. About 80 per cent. were good; those that were spoiled seemed to be in a state of decay—offensive. Most of the eggs not spoiled were segmented. Mean temperature this day, 67° F.

At noon, south of the Republican, found very few eggs on any kind of land; 80 per cent. good.

Reached Manning's this evening.

Manning's, Furnas County, March 29, 1877.—This morning above the house, on old breaking, found a few eggs in the same condition as those found yesterday; found no live ones.

At noon at Indianola, Red Willow County, examined the ground; found only one spot that contained any eggs—about 150 to the square foot. Of these 30 per cent. had been hatched out; a few were decayed. About 60 per cent. appeared good; most of these were segmented. Mean temperature to-day, 50° F. This day unusually disagreeable.

Fitch's Hitchcock County, March 30, 1877.—Cold, chilly morning. Dried my clothes and started away at nine; crossed the Deadwood and went to Nettleton's; went up the Driftwood fifteen miles and examined the ground in various places for locust eggs;

found only a few places on bare hill-sides where there were about fifty eggs to a square foot; most on second terrace and the bluffs; very few eggs here seemed to be spoiled; camped near section corner between 10, 11, 14, and 15, township 1 north, range 32 west; few locust eggs here; mean temperature 48° Fahrenheit.

Camp, Hitchcock County, March 31, 1877.—This morning hunted an hour before finding any locust-eggs. Found a few on the hills of an old, abandoned; prairie-dog town not more than from 30 to 60 to a square foot.

Camp, Hitchcock County, April 1, 1877.—Camp about thirty miles west of Culbertson. Sandy, and intensely cold. Found a few locust-eggs in the cave where we were camped in the sand, about 30 to a square foot. None around this point elsewhere. After breakfast weather began to moderate; walked south for three miles. Found no locust-eggs, though I examined the ground in the most favorable spots for them.

At 2 p. m., temperature had risen to 25° above zero F. Started up the valley. Half an hour before sundown found a good camping-ground about two miles above the forks of the Republican, on South Fork. Here in the bluffs found a few locust-eggs—about 30 to a square foot.

Camp, Dundy County, two miles west of forks, April 2, 1877.—Wind from the south; cold and blowing hard. Along the southwest slopes of the bluffs along this creek found a few locust-eggs near the Kansas line—about 60 to a square foot. We were much chilled by this ride.

After our return, and dinner over, we crossed the South Fork of the Republican and across the peninsula between the two rivers. On top of this, about half-way between the rivers, found a few locust-eggs—not more than about 60 to a square foot. Went up the North Fork after it was reached, about eight miles. Camped in a cave. Found no eggs of locusts along the river. Mean temperature this day, 45° F.

Ten miles above forks of Republican, Dundy County, April 3, 1877.—Going up the river and examining the ground in many places; found locust-eggs only in one spot, on a second terrace—about 30 to a square yard. Reached the Arickaree River, which flows into the Republican from the southwest. Took dinner here.

From some young men here engaged in herding cattle, learned that there were few locust-eggs laid in this section. About a mile above this, on high land, at the foot of bluffs, found a nest of eggs containing 30 eggs.

Reached the Colorado line about four p. m., and at six, about four miles farther, camped. Mean temperature 46½° F.

On Republican, four miles beyond the Nebraska line, in Colorado, April 4, 1877.—Traveled this day to head of the Republican, where it rises in a shallow basin; went above this on to the Colorado plain, then returned and camped at an old burnt-down sod house. Found no locust-eggs this day, though I looked diligently. Found the head of the river by barometer to be 4,050 feet above the sea-level.

Republican, fifteen miles west of Nebraska line, April 5, 1877.—Came down the valley some 15 miles to-day, but found no locust-eggs, but in a few places on high, sandy terraces a few newly-hatched locusts; mean temperature, 48° F.

April 6, 1877.—Spent most of this day in boring, but examined the soil carefully for locust-eggs; found none. Towards evening came down the river to mouth of the Arickaree, where staid all night in hut, Perkins & Co.'s ranch. Mean temperature, 7° F.

Lincoln, April 11, 1877.—Reached Lincoln to-day at noon. This afternoon went east to Antelope and beyond. Part of the locust-eggs seemed well on in hatching, about one-half hatched. In low places—bottoms—the largest part seemed spoiled. Some few nests had the lower tier hatched out.

Lincoln, April 12, 1877.—Considerable numbers of locusts hatched out to-day. Mean temperature, 50° F. They feed on the young grass.

To-day exposed same 20 nests that had commenced to hatch; seemed to be about one-half formed. Break their covering. South side of the Antelope. Great fears are entertained by the people that the crop will be destroyed.

Lincoln, Friday, April 13, 1877.—Mean temperature to-day, 52° F. Went to south side of the Antelope. Many hatching out. Examined the 20 nests that I had exposed yesterday. They seem to be shriveling up. Exposed 20 more.

Vast numbers are hatching out on the capitol grounds. Many eggs are bottled and sent away.

Went to South Lincoln and found vast numbers hatching out. At this rate the great body of them will soon be out.

Lincoln, April 14, 1877.—Mean temperature to-day, 70° F. Locusts hatched out to-day in enormous numbers. Southwest wind.

Examined the eggs that I had exposed on south side of the Antelope. First lot withered and destroyed by the exposure. Exposed a new lot that were almost ready to come out of the shell, also a few that I found that were yet unsegmented.

On the capitol grounds the locusts were coming out in great numbers, also in South Lincoln and for miles in the country. In South Lincoln exposed a large number that were about ready to come out. Found large clusters in many places—many pale ones and an equal number that had reached a dark color. Hear of them hatching out in several adjoining counties and in various portions of the State.

By examining the ground closely with a glass found thousands of dead ones, shriveled up and merging with the soil, not merely the cast off cuticles, but the entire locust. Probable cause of death, either cool nights, want of food, or *lack of constitutional vigor.*

Lincoln, Sunday, April 15, 1877.—Temperature at 9 a. m., 59° F.; at 12 m., 70° F.; at 2 p. m., 80° F. in shade, and sheltered. In wind much higher; wind from southwest.

Locusts hatched out to-day in unprecedented numbers. Wherever there were eggs locusts seemed to swarm out. Ground in many places covered with them. Some places the ground seemed white with the newly-born locusts.

Examined the eggs that I had exposed in South Lincoln and east of the Antelope and found them partially dried and shriveled up. Judging from these experiments the laying bare of eggs will, if left exposed, destroy them. Some few live ones are eating prairie-grass east of the Antelope.

I learn from a few persons who have come up by buggy from Beatrice that the locusts come out of the ground there by the countless millions—ground white with them and all the way between this and Beatrice. They cover the lower trunks of trees and the grass in spots being destroyed by them.

Lincoln, Monday, April 16, 1877.—Temperature at 9 a. m., 50° F.; at 12 m., 69° F.; at 2 p. m., 71° F. Southwest wind still blowing. Cloudy and sultry. Locusts still hatching out. Ground still, in places, alive with them. Have observed them eating grass on the prairie south of the capitol. Many clustering, moving south. Went into the country seven miles south of the penitentiary and found them at work on the wheat.

To-night a terrific hail and rain-storm, with loud thunder and intense lightning, occurred. Ground flooded and still warm.

Lincoln, Tuesday, April 17, 1877.—Ground this morning very wet. Many low places are still, and more must have been, under water last night.

Temperature at 9 a. m., 58° F.; at 12 m., 68° F.; at 2 p. m., 71° F.; southwest wind.

At 2 p. m. went south of town. Locusts lively. Saw many drowned and dead ones in low places. Locusts eating prairie-grass and the borders of some fields. Still many more are coming out.

Lincoln, Wednesday, April 18, 1877.—Rained hard to-day. Some severe claps of thunder. In the evening, east of Lincoln, found thousands of locusts floating. Found few live ones. They seemed to be hid away under stems, bushes, dead and live grass. None hatching out to-day.

Temperature at 9 a. m., 48° F.; 12 m., 60° F.; at 2 p. m., 64° F.

Lincoln, Thursday, April 19, 1877.—Temperature at 9 a. m., 50° F.; at 12 m., 62° F.; at 2 p. m., 68° F.

After dinner found thousands of dead locusts east of the Antelope. Difficult to find from their minuteness and the grass. Used a large glass. Could not estimate the number and per cent. of dead ones; probably 10 per cent. of those that had hatched out up to this time. Those not dead generally lively, but some seemed sick. Saw some again eating prairie-grass. Still moving southward. Hear of them commencing on wheat-fields up the valley—Oak Creek.

Lincoln, Friday, April 20, 1877.—Temperature at 9 a. m., 49° F.; 12 m, 64° F.; 2 p. m., 63° F.

Many locusts hatched out again to-day. Five miles south of Lincoln, where great numbers were reputed to be found, only vast numbers of dead ones in spots. Am more and more convinced that their dying is caused by lack of constitutional vigor.

Saturday, April 21, 1877.—Temperature at 9 a. m., 48° F.; 12 m., 66° F.; 2 p. m., 70° F.

Locusts hatched out to some extent to-day. In examining the nests, found that the under ones came out first. They still keep in bunches. Though many have died and many still dying, their numbers not sensibly diminished. Above the salt basins west of Lincoln found a great number of half-rotten and half-hatched-out nests.

At noon started for Omaha. Found locusts in spots along the road at stations, but comparatively few in numbers. Along the Bluffs at Bellview, twelve miles from Omaha, found many nests of half-rotten eggs.

At Omaha, went west of town as far as Popellion bottom. Here on the bottom found 90 per cent. of the eggs spoiled; above the bottom found only about 10 per cent. spoiled on some old breaking, where the eggs averaged about 1,000 to a square foot.

Omaha, Sunday, April 22, 1877.—Went south of Omaha. Locusts in spots. Found many unhatched nests of eggs, some rotten and some sound; probably 50 per cent. rotten on low land and about 10 per cent. on upland. Evidently low, wet land the most unhealthy for them.

Lincoln, May 2, 1877.—On my return to-day from the east, with wife and child, saw nothing of note until I arrived at Waverly. Here, a few rods from the station, found a large number of locusts just hatched. Many were, from some cause, barely able to move, and others apparently dying. Could not ascertain the cause.

Lincoln, May 3, 1877.—This afternoon, on the disputed 80, just east of Lincoln, found thousands of dead locusts. Had to examine the ground closely with a large magnifying-glass in order to distinguish them. The newspapers claim that many were destroyed by the storm on the —th of April. Few of the people, however, believe that many were then killed. Probabilities are that millions died, but owing to the fact that they almost immediately merge with the soil after death, especially when young, they cannot be seen, and are unnoticed.

Lincoln, May 4, 1877.—Went this afternoon to Mr. Adams's place, one mile southeast of Lincoln. Temperature at 9 a. m., 50° F.; a at 12 m., 65° F.; at 2 p. m., 66° F.

One lot of Mr. Adams's was plowed early in March. Millions of locusts were plowed under. By digging, found thousands of these hatched out and dead, being unable to work through the ground. Depth from one and a half to four inches, at which hatched ones were found, though the number hatched out at that depth was very few; the great body of eggs at four inches unhatched or in process of decay. The great body cease to hatch out below two and a half inches.

On Adams's ground, where the ground was not plowed under, millions of locusts covered the ground. They clustered in patches. This place is slightly elevated above the general level. If all this ground had been plowed under early in the spring or late in autumn, the greater part of the locusts would have been destroyed.

At Guthridge's, northeast from Adams's—also a market-gardener—the ground was all plowed deeply early in the spring, and few locusts are there. It lies a little lower, and probably not so many eggs were laid there.

Just across the road, and south of Adams's house a few rods, the young locusts were beginning to eat the wheat. There were great numbers in patches.

Appearances seem to indicate that a large number of the locusts here have hatched out. By long and close looking found a considerable number of minute dead locusts, killed probably by the recent wet and cold.

Lincoln, Saturday, May 5, 1877.—Temperature at 9 a. m., 50° F.; at 12 m., 51° F.; at 2 p. m. 50° F.

Drizzling rain and chilly. Locusts stupid and dying. Found them in heaps east of the University on the disputed 80. East of the Antelope they seemed in a healthier condition. Rained hard most of the afternoon and evening.

Lincoln, Sunday, May 6, 1877.—Temperature at 9 a. m., 45° F.; 12 m., 52° F.; 2 p. m., 50° F. In wind, temperature lower—blowing from the north.

On Salt Creek bottom found thousands of dead locusts; seemed to have been drowned or killed by the cold and severe rain. Found many that were numb and some dead ones even on the high lands.

Lincoln, Monday, May 7, 1877.—Temperature at 9 a. m., 45° F.; at 12 m., 55° F.; at 2 p. m., 60° F. Found many dead locusts again to-day. Three miles east of the university, in a hollow, found dead locusts two inches deep. Must have been washed together. Evidently less locusts than two weeks ago. I hear the same from other sections, especially Sarpy, Saunders, and Cass Counties.

Lincoln, May 9, 1877.—Temperature at 9 a. m., 46° F.; at 12 m., 57° F.; 2 p. m., 65° F. Rained much of the day and could not get out to examine the locusts. On the disputed 80 east of Lincoln, found many dead locusts, by looking closely with a glass. Most of the locusts about one size, one-fourth to one-third grown. Youngest must have perished in the could and rains. Reports favorable as to the little damage done.

On Poor Farm, up Oak Creek, the wheat was taken close to the ground. I advised plowing under to bury the unhatched eggs. They did so and few have since appeared. On neighboring farm of Dr. Lattas the locusts were coming out by the million when furrowing out the corn ground; advised the same thing there. This covered up the ground deep enough, I hope, to destroy the eggs.

Lincoln, Thursday, May 10, 1877.—Mean temperature to-day, 70° F.

Rained greater part of to-day. Toward evening rode two miles east of town. Found many dead locusts again. On one spot where they seemed to have been washed together counted 411 small dead locusts on one square foot of soil. Found many dead ones at the base of weeds where they had apparently hidden. At another point south of Hawley's farm saw a large flock of blackbirds and yellow-heads feeding on the young locusts.

Lincoln, Friday, May 11, 1877.—Spent some time to-day in examining the spots abounding in dead locusts. Found a few with defective mouth parts; evidently could not chew. But most of the dead ones had these parts perfect. Their dying must be produced by decay of constitutional vigor. They are evidently dying in spots with great rapidity; much more in some places than in others. Some places die younger than at others.

Lincoln, May 12, 1877.—Mean temperature to-day, 70° F. Rained hard last night. Roads a mass of mud. This afternoon on banks of the Antelope found millions apparently of dead locusts; some still hatching out but slowly. The greater part of those now coming out are dying.

Lincoln, Monday, May 14, 1877.—Temperature at 9 a. m., 70° F.; at 12 m., 72° F.; at

2 p. m. 70° F. Rain again this forenoon and evening. Few locusts to be seen except on fences and weeds. All small—old ones seem mostly to have died off.

This afternoon went to Salt Creek bottom, and, as usual, found a large number of dead ones. All the living ones nearly of the same size. Found the same condition of things south of the penitentiary. Here on top of the bluffs many live ones and few dead. On bottom many dead and few live ones. Found an unusual number that had worked into the edge of the timber, where blackbirds and quail were working on them.

Sent off large number of bulletins of Entomological Commission to-day.

Lincoln, Tuesday, May 15, 1877.—Near Waverly to-day on the bottoms found great numbers of dead locusts and many dying, coming out of the ground just about as fast as dying. On the uplands they grow a trifle larger before dying. The dead ones that I found to-day nearly a line longer on the uplands than in the valleys.

Lincoln, Wednesday, May 16, 1877.—Temperature at 9 a. m., 71° F.; at 12 m., 73° F.; at 2 p. m., 70° F. Rain in the morning; clear betimes during the middle of the day; rain again at evening; south winds. Some still hatching out. Observed some coming out of the ground on the disputed 8°. Seemed hardly able to shed their pellicle. Some died in making the effort. About one-half of those I saw coming out of the ground to-day died in the effort to shed the first skin. The weather probably helps to hasten their death.

The new breaking on Hudson's land, south of Lincoln about one mile, still full of locust eggs; only one-third hatched out.

Lincoln, Thursday, May 17, 1877.—Temperature 9 a. m., 60° F.; 12 m., 80° F.; 2 p. m., 86° F. Clear all day until toward evening. Enormous number of locusts came out of the ground to-day. An unusual number seen to-day. None, however, appeared over a week old.

At 2 p. m. went to Historical Block to experiment with tar-pan to catch young locusts. This one six feet long, eighteen inches high, and twenty-four inches from front to rear. Sheet-iron cross-sections at bottom. One pint of coal-oil destroyed about one-half bushel of locusts. The fumes of coal-oil kill the young locusts. This machine can be dragged by two boys over about ten acres in a day.

Again found millions of dead locusts, some with my glass, and others were heaped together by water currents. This near Holmes's brick-kiln, west of town. One place found dead locusts three inches thick on the ground. This evening again experimented with the coal-oil pan. Tried tar. Laid on thin at bottom, and when locusts got too thick, another layer is put on and then another. When filled all is scraped off and boiled. The locusts are skimmed off, the tar thinned with coal-oil, and used again.

Heard this evening from Mr. Raymond, of Falls City, that the young locusts have mostly died there. Farmers there expect a crop.

Lincoln, Friday, May 18, 1877.—Mean temperature to-day, 70° F. Rained nearly all last night and this forenoon; ceased this afternoon, and the locusts appeared on weeds and fences, but all small.

Again found many dead ones beyond the Antelope and up Salt Creek. On Salt Creek again found dead locusts about two inches thick in some low places where the water had washed them together.

Lincoln, Saturday, May 19, 1877.—Temperature 9 a. m., 65° F.; 12 m., 69° F.; 2 p. m., 70° F. Rained hard again all last night.

Was mowing and house-cleaning to-day and made few observations. Only sent off a great number of Entomological Bulletins.

Lincoln, Sunday, May 20, 1877.—Mean temperature to-day, 75° F. Rained all last night and most of the forenoon. Salt Creek overflows its banks. Found dead locusts to-day almost wherever I looked for them.

Lincoln, Monday, May 21, 1877.—Temperature 9 a. m., 68° F.; 12 m., 72° F.; 2 p. m., 79° F. Found many dead and dying locusts to-day. Weather sultry. Locusts seem to die off as fast in warm wet weather as in cold wet weather.

Sent off a great many circulars and bulletins of the Entomological Commission.

This evening a swarm of locusts lit down at Grand Island and around it. Came from a little east of south. Telegram. Lieutenant-Governor Abbott's authority. Probably came from Texas.

Lincoln, Tuesday, May 22, 1877.—Temperature 9 a. m., 67° F.; 12 m., 74° F.; 2 p. m., 78° F. Telegram from Grand Island: "Locusts left this morning. Direction a little east of north."

This afternoon again tried the machine for catching locusts with coal-oil. Successful. Caught half a bushel in half an hour on the bottoms near Salt Creek. On north side of Salt Creek bottoms found one spot where the dead locusts were half an inch thick.

Lincoln, Wednesday, May 23, 1877.—Temperature 9 a. m., 60° F.; 12 m., 67° F.; 2 p. m., 69° F. Went east beyond the Antelope. Again examined bottoms and uplands for dead locusts. Found dead ones in all situations, but those on the uplands averaged one line longer than those on the bottoms. A considerable number still hatching out. On the road-sides and on old breaking found a considerable number of unhatched eggs,

and more rotten ones. South of Lincoln, on Hudson's breaking, locusts still hatching out.

Lincoln, Thursday, May 24, 1877.—Mean temperature to-day, 70° F. Continued investigations to-day four miles north of Lincoln. Found the dead locusts on high lands again average nearly a line longer than those on the low lands. They probably can survive longest in the driest situations.

Lincoln, Friday, May 25, 1877.—Temperature, 9 a. m., 65° F.; 12 m., 70° F.; 2 p. m., 75° F. Received many letters of inquiry about the locusts. Farmers generally much encouraged, and begin to think the locust question settled. This is specially the case where they fight them with coal-oil and other pans. They in such places think that what nature does not do they can accomplish.

Lincoln, Saturday, May 26, 1877.—Temperature, 10 a. m., 69° F.; 12 m., 70° F.; 2 p. m., 79° F. A few more locusts hatched out to-day, and yet their numbers are not increasing.

Lincoln, Sunday, May 27, 1877.—Temperature at 9 a. m., 58° F.; 12 m., 67° F.; 2 p. m., 79° F. This afternoon, though warm, found many locusts dying beyond the Antelope and elsewhere around town. Some other cause than low temperature evidently fatal to the locusts. Rained heavily this afternoon.

Lincoln, Monday, May 28, 1877.—Temperature, 9 a. m., 64° F.; 12 m., 68° F.; 2 p. m., 77° F. Another large hatch of locusts hatched out this afternoon. Many small ones again visible. Occasionally there is one half grown. Caught first locust-mite of this season to-day. South wind all day.

Lincoln, Tuesday, May 29, 1877.—Temperature, 9 a. m., 67° F.; 12 m., 73° F.; 2 p. m., 79° F. This afternoon went to South Lincoln and some miles into the country. Where the young locusts were abundant yesterday and the day before, hardly one to be seen to-day alive, but many dead ones, another evidence that most die within a few days of the time that they hatch out. At Hudson's breaking found still a great number of unhatched eggs. In evening went east beyond the Antelope to a ridge of land. Here also found few live, but many dead ones. Wind blowing from the south all day, and blowing hard.

Lincoln, Wednesday, May 30, 1877.—Temperature, 9 a. m., 68° F.; 12 m., 71° F.; 2 p. m., 80° F. Wind blowing hard from the south all day. Some few locusts to be seen, but few, not many, hatching out. The supply gives signs of being exhausted.

Heard to-day that the western part of Nemaha County was desolated in part by the locusts; probably exaggerated. People fighting them by ditches, nets, and coal-oil pans. Will probably succeed in saving their crops.

At 4 p. m. a sudden fall of temperature, though the wind was still blowing from the south. Fell in half an hour from 80° F. to 60° F.; in half an hour more to 55° F. At dusk rain began to fall in torrents, and continued until 9.30 p. m.

Lincoln, Thursday, May 31, 1877.—Temperature, 9 a. m., 55° F.; 12 m., 74½° F.; 2 p. m., 74° F. This morning wind still from south, but clear.

To-day, a few miles from Lincoln, on Oak Creek and elsewhere, again found a great number of dead locusts. In an eddy in the creek found bushels; on the land in several places found them one and two inches deep. An unusual number died or were destroyed since yesterday.

Lincoln, Saturday, June 2, 1877.—Mean temperature, 63° F. Went with Mr. Leavitt and Budd 12 miles south of Lincoln this afternoon. Found only one place where the locusts were doing much injury, this 6 miles south of Lincoln. Here there must have been over 500 to a square foot on small areas of a few rods in extent. One corner of wheat-field entirely destroyed. The owner not doing much to protect himself; trusts to Providence. At the foot of a hill here, found dead locusts ½ inch deep; had been washed together by the rains. Also found near this place a great number of locusts with defective mouth-parts; could not eat. This probably the cause of the dying off of many at this place. Some of the farmers here testify to this; also to the fact that great numbers have died and are dying.

All the farmers consulted testified that there were not near so many locusts as there were three weeks and a month ago. They had little fear of them.

Lincoln, Sunday, June 3, 1877.—Temperature, 9 a. m., 57° F.; 12 m., 71°; 2 p. m., 78° F. At the Antelope found a few more unhatched eggs to-day. To-day the birds here, especially quail, Bartramian plover, and blackbirds, were unusually busy in picking up stray locusts. Watched them for an hour doing this.

Learned by telegraph that the locusts from the south lit down in large numbers, coming from the south, and remained 2½ hours, when they went on north.

Lincoln, Monday, June 4, 1877.—Temperature, 9 a. m., 50° F.; 12 m., 61° F; 2 p. m., 70° F. Rained heavily last night. Received a letter to-day from Wahac, Saunders County. It reports the locusts as dying there in immense numbers. Where the water can wash them together they often lie from ½ to 2 inches deep. A letter from Reamer, in Richardson County, says that immense numbers of kerosene-pans are there employed to kill the locusts, and that it is successfully done.

Lincoln, Tuesday, June 5, 1877.—Mean temperature, 65°. Letter to-day from L. Beckman, at Beatrice, says that though countless numbers have hatched out there, few are left. No one knows where they have gone to, but all suspect that they have died or have been eaten by birds, or that both causes have operated to destroy them. Only a few fields have been injured by the locusts, and the farmers all hopeful.

Lincoln, Wednesday, June 6, 1877.—Mean temperature to-day, 67° F. Rained last night and a little to-day. Letter from Johnson County, from Sol. Soder, reports that the locusts have in a few places done some damage, but that in spots they have mysteriously disappeared. On a few places the farmers were fighting what were left with kerosene-pans. This day noon Professor Thomas came, and I had my first interview with him at 3 p. m., at the Commercial Hotel. * * * Discussed generally with him the locust question.

Lincoln, Thursday, June 7, 1877.—Mean temperature to-day, 63° F. This forenoon went with Professor Thomas and Dr. Weelckines to South Lincoln and to Adams's market-gardens, one mile southeast of Lincoln. Found a considerable number of locusts here, and doing much damage to a portion of his grounds. The part plowed sufficiently in early spring escaped, except from the immigration onto it of locusts hatched out elsewhere.

Missed the train to go to Tecumseh with Professor Thomas. Received letter from James Dollman, Pawnee City, Pawnee County. He reports that little damage is done to the crops by the locusts, though they hatched out in large numbers, and then in spots over large areas mysteriously disappeared, but how he cannot tell.

Lincoln, Friday, June 9, 1877.—Mean temperature, 66° F. Went to Falls City to-day. Saw Professor Thomas at Tecumseh for only a few moments while train stopped. Rained much of the day. Found locusts doing considerable damage around Humboldt, Table Rock, and Falls City. At Falls City, 700 kerosene-machines have been made and sold to the farmers in the country. The damage being done is in separated areas, and those farmers that are fighting them are doing it successfully. Some, however, do nothing, and the town-people are more zealous and more successful in inciting to such efforts than the farmers themselves. I found by experience at Falls City that some farmers were so faithless that it was with difficulty that they could be induced to make the effort. Rain and mud interfered with making a thorough examination.

Lincoln, Saturday, June 9, 1877.—Left Falls City at 7.30 this morning. Professor Thomas joined me at Tecumseh. He had been much exercised at Tecumseh about the locusts, as they were doing some damage here in spots, and the farmers were not doing much to head them off. Professor T. aroused them to the importance of the effort to destroy the locusts, and was aided by Mr. O. U. Holmes. They succeeded in inspiring confidence in the feasibility of destroying the locusts and led many to make the effort. Those that manfully made the attempt succeeded.

Sutton, June 11, 1877.—Left Lincoln to-day at 12 45. Saw few traces of locusts on our way here. Found a considerable number of dead and dying locusts. At the present rate of dying or disappearing, the remainder of this field will probably escape destruction. Locusts here very thicks, epecially through the middle of the orchard. He had a man putting a coating of whiting on the trees to prevent the locusts crawling up the trees. Locusts principally came in from an adjoining field on the east, eating up the timothy in the orchard. A ditch commenced on the north side of the orchard, and this method—ditching—is most confided in here for destroying the locusts. All seemed to rely on this method.

Rained hard in the afternoon, between three and four. After seeing this field, we went to see the farm of Hon. J. Sterling Morton, 1½ miles from town, on the north. Here the locusts were abundant in spots. They had dug a ditch in front of the house, in which they had captured an immense number of locusts. They had also tried the kerosene and tar pans with only partial success, and esteemed it rather lightly. Professor Thomas tried to convince Mr. Morton's son that if he gave this plan a fair trial it would be a success. The locusts were specially abundant in and damaging to the clover. On the whole, they were encouraged to believe that they had found out how to meet the locusts and to destroy them.

Fremont, June 14, 1877.—Came here at 2 p. m. Saw Mr. Rogers soon after at the bank. He took me to the northern part of the town, where, in the grounds of Mr. ———, a market-gardener, the locusts were doing animmense amount of damage. They had eaten all the strawberries, tomatoes, potatoes, &c., in one half of his grounds. In the other half he was trying to destroy them with kerosene-pans, by dragging, and also by ditching. He confessed that if he had commenced in time, he could have saved all his grounds, though the greatest part of the locusts came in from his careless neighbors' grounds. Thinks that hereafter the remedy is in his hands. He also thinks that they are slowly disappearing. The locusts here of all ages; some able to fly, and have mature wings, while others seem to be but a few days old. Still farther north a half a mile, I visited a field that was about one-quarter eaten on one side by the locusts, and

the man doing nothing to destroy them. Most of these seemed to have hatched out in breaking of last year.

After supper at Mr. Rogers's, he took me out to Judge Maxfield's, who lives within two miles of town, on a small farm. He had ditched around his grounds and through them, and thus had saved his crops. They had been quite bad here, and he attributed his success wholly to his industry in fighting them. He depended most on ditching. Between the judge's homestead and town one farm only was badly eaten, and that only on one side. The owner was doing nothing to protect himself.

Lincoln, June 18, 1877.—Many locusts now getting wings and testing them by flying up into the air and an unusual number dying. I learn from visitors here that on the Elkhorn and in Northeast Nebraska the locusts only doing damage in isolated spots, and in many places have mysteriously disappeared.

Went with some parties southwest about five miles, and found the locusts thick in spots and doing a little damage and immense numbers dying. A small maggot—ichneuman fly—at work on them.

Lincoln, June 23, 1877.—Returned from Nemaha County to-day. In west part of the county the locusts in spots did much damage. Many farmers could have saved their crops, but made no effort until it was too late. All admitted that all the crops could have been saved by proper effort, and regretted that they had no faith in the kerosene-pans until the damage was done. I succeeded in getting many at this late period to adopt this method of fighting them. Some places partially eaten up, and fields were in part covered with dead locusts. The dead and dying locusts that I examined nearly all contained a great number of minute maggots, some one-eighth and others from one-third to one-fourth of an inch long, with a narrow red streak along the back.

Lincoln, June 25, 1877.—Went with Professor Hitchcock to-day to see the grain-fields on his farm, five miles west of Lincoln. The field slopes toward the north. Grain, what was left, heading out, but it has been so badly damaged by the locusts that probably he won't have the seed. The Swedes who are farming his land did not observe the damage that they were doing until it was too late. Now Professor Hitchcock proposes to plow under and plant in corn.

Here many of the locusts able to fly. An immense number of dead locusts here, some with fully-developed wings and some two-thirds grown. Many of the locusts just dying. Some were barely able to fly, some could only jump a few inches, and some could only crawl, and some were kicking in death. The afternoon warm and pleasant. I examined an immense number of these dead locusts. I could have gathered a peck from one-fourth of an acre. Found in many of these dead and dying locusts a small maggot from one-eighth to one-fourth of an inch in length. Perhaps three fourths of the locusts that I examined contained this maggot, varying from three to ten in a locust. The maggots had a narrow streak of red along the back. Small red mite also abundant on many dying locusts.

Lincoln, June 26, 1877.—Temperature (mean) to-day 81° F. Wind from south by southwest. This is the first day that the locusts moved any distance. About 11 o'clock they rose gradually and a few moved north, and about 12 m. 20° east of north. At three o'clock p. m. all the movements seemed to have ceased. Great numbers, as I watched them with my glass, seemed to whirl around in a circle and come down again. Some that did this fell dead, and these, when examined, had in them a small maggot, with a narrow red line along the spine. Column three-fourths of a mile high; sparse; velocity, 5 miles an hour. Rain last night.

Lincoln, June 27, 1877.—Mean temerature to-day 77° F. Some rain last night. At ten o'clock a few locusts again rose up in the air and slightly increased until 1 o'clock p. m., from which time they decreased until 2.30 p. m, when the flying ceased. Direction, 22° east of north. A small column of locusts was moving north in the same direction, above the plane of those that were starting from this place. They must have come from South Nebraska or Kansas. Many fell down dead from the flying mass, but had no parasites on or in them that I could detect, except a few that had a small maggot from one-third to one-fourth of an inch long in them, with the red stripe down the length of its back. Velocity of the rising ones, 5½ miles an hour.

North Platte, Nebr., June 30, 1877.—Reached here last night about 2 a. m.

Yesterday afternoon saw the locusts in small numbers flying around in the air at various places between Crete and Kearney, and it was hard to determine in what direction they were about or wanted to go. They seemed entirely demoralized. As they had mostly disappeared over this section before flying-time, those on the wing probably came from the south. Here at North Platte there are comparatively few locusts; found only scattering ones as I went round with La Nunion. Drove some eight miles out among the sand-hills.

Kearney Junction, July 2, 1877.—This afternoon, coming from North Platte, I found a considerable number of locusts east and west of Ogallala, on the N. road. They had lit down here on their way north from the south. Not enough to do any damage unless they should lay their eggs here, which is not likely, considering the earliness

of the season. A good many were in the air at ten o'clock, apparently moving a little east of north. At noon very thick, moving 15° east of north. Velocity, 6 miles an hour.

All the crops are good between North Platte and Kearney. Abundance of rain this season, and the locusts did no harm. Rain-fall at least 50 per cent. greater this season than last or the year previous to the last.

Schuyler, Colfax County, July 3, 1877.—Reached here to-day at 12 m. This afternoon was taken by Mr. Clarkson, first south across the Platte, and then east over the bottoms, and then the bluffs. Traveled about 12 miles. Saw little damage done by the locusts. Only an occasional field had been injured, and many that had been hurt in the early part of the season recovered themselves as the locusts died off. All the crops magnificent. A few locusts flying again towards the north, or a little east of north, at ten o'clock. At noon and till two o'clock, great numbers moving north. Velocity, 5½ miles an hour; height, ¾ of a mile.

Schuyler, Colfax County, July 4, 1877.—This afternoon went across the Platte bottom towards the north and struck the Shell Creek bottom, which we mainly followed for fourteen miles. Only about one field in fifteen had been injured by the locusts. The farmers that had fought the locusts succeeded in saving their crops, even where the locusts were the thickest. Those few that lost portions of their crops did nothing to fight the locusts. Crops splendid. Saw very many locusts moving north again to-day, north 20° east. A few were falling down dead or dying. Those that I examined had either the red dorsal-striped maggot in them or nothing that I could detect. One-third composed those without anything. Velocity, 5½ miles an hour; height, nearly a mile, but sparse. Saw two gentlemen, whose names I cannot recall, direct from the Black Hills, who report that the locusts came there in large numbers from the south and were already laying their eggs there. They report them to be specially abundant around the south edge of the Hills.

Omaha, July 5, 1877.—This evening I met Lawrence Bruner, who had also received letters from the Black Hills stating that the locusts that had lit down there from the south were laying their eggs, thus confirming the report that I received from the Black Hills at Schuyler. Here in Omaha there seems to be universal satisfaction now with the work of the Entomological Commission—more so than at any previous date. Some locusts moving 17° east of north and about 4 miles an hour, and three-fourths of a mile high.

Lincoln, July 6, 1877.—Returned home to-day from Omaha. Some locusts flying to-day—a few rising and more in the air, from distant regions. They were moving about 25° east of north. Saw them from the Missouri river to Lincoln. Rate, about 5 miles an hour. A few falling down dead; those that I examined had either maggots in them or had from two to twelve red mites, mostly near the base of their wings.

Lincoln, July 9.—Large numbers of locusts were flying south to-day. Column nearly a mile high; thick above and sparse below. Velocity 7 miles an hour. Flew from ten to half-past two o'clock. A few fell down dead from the moving mass.

July 10.—A few locusts flew south to-day.

Plattsmouth, July 12, 1877.—Locusts flying 20° west of north over Plattsmouth to-day, in large numbers. Went over the Missouri into Iowa, and found the same condition of things there. They must have come from southwestern Iowa, though I supposed that they had left there long ago. Estimated velocity, 6 miles an hour. Column a mile high; upper portion sparse.

Lincoln, July 13, 1877.—Returned to-day from Plattsmouth. Locusts all along the road between this and Plattsmouth, moving towards the northwest, about 20° west of north. Velocity 6 miles an hour. Barley and rye are being harvested in a splendid condition. In a week more a great deal of wheat will be cut. The flying south of locusts several days back has produced some anxiety.

Lincoln, Sunday, July 15, 1877.—To-day, between 10 a. m. and 2 p. m., the locusts were flying south over Lincoln, probably only because the wind happened to be in that direction. They were very high in the air. A rough trigonometrical measurement made the distance three-quarters of a mile to the upper edge of the locusts. Velocity about 6 miles an hour. Have not heard of them lighting down anywhere in their southern flight.

Lincoln, July 18, 1877.—To-day, from 10 to 1 o'clock, the locusts were moving south, or a little east of south, in considerable numbers. About 12 m. the numbers were specially large. Some fell down as they were flying, either dead or in a dying condition. Only a few of those falling had parasites in them, and these parasites were all grubs, with the red line along the back. Have not been able to hear of them lighting down anywhere, though I have sent and telegraphed in various directions.

Sioux City, July 20, 1877.—Some locusts flying south to-day over Sioux City. Yesterday a few were flying north while on my way from Lincoln to Omaha. Velocity, 6 miles an hour. Estimated the velocity by walking as fast as they flew, and noting how long it took me to go 100 yards.

Dakota City, July 20, 1877.—As I came down from Sioux City to Dakota, just as I

was getting on the cars, and for a few minutes afterwards, one stream of locusts were flying north and another above this stream, about half a mile above it, was moving south. At the edge, where the two streams met, the locusts seemed to intermingle. Both streams comparatively sparse.

Dakota City, Saturday, July 21, 1877.—At ten o'clock a few locusts were seen moving north, and at eleven a stream above this northward-moving column was again going south. Around town there are still some locusts left, but not doing any particular damage. Movement of upper current six, and of the lower five miles an hour. Both comparatively sparse.

Dakota City, Sunday, July 22, 1877.—After church, this forenoon, I went into the country five miles, to the farm of Jacob Neikes. On the way some few locusts were on the wing, mostly moving north. Mr. Neikes's grain-field, east of his house, as also his corn-field, is in danger of being destroyed. Great numbers of locusts have lighted in it from those coming from the north; at least, this is the statement of those living here. In going among these locusts, great numbers seemed to be diseased. Some were hardly able to fly, and a few were either dying or dead. Found some parasites on these, chiefly the grub, before mentioned, or else the red mites. On an adjoining farm, William Armor's, the locusts had come down from the north, and after remaining a few days went back in the direction from which they came. Returned to Dakota this evening. The birds destroying many locusts here.

Monday, July 23, 1877, *five miles south of Dakota City.*—To-day went with a party to a land-slide at the bluffs, ten miles south of Dakota City and near Lee Warner's farm. Some locust flying to-day in a northeastern direction. Lee Warner insisted to day that lime-water, instead of coal-oil, had answered every purpose for him in capturing locusts with pans. Among the locusts flying to-day cliff swallows were at work. Some Bartramian plover were mounting up into the air to capture them. Stopped at Dearing's all night.

Tuesday, July 24, 1877, *five miles southwest of Dakota.*—Came to-day to Mr. Neikes's from Dearing's. The locusts still at work on his grain-field east of his house and on his oats, west of his residence. On the oats specially bad. He commenced to cut them in order to save them. Some of the locusts on his and the adjoining farm that were working on the wheat moved north to-day, but still there are great numbers left. Going among his wheat, I found great numbers of dead locusts. Some gave no evidence of death from parasites, while others had a few mites on them or larvæ of ichneumons in them.

Dakota City, Wednesday, July 25, 1877.—Went to William Brown's yesterday afternoon, from J. Steeke's. Brown has been here only a year and is somewhat discouraged. His cultivated land is mostly new breaking, and more than one-half of his wheat was destroyed by the locusts that hatched out here, and came over from an adjoining farm. He admits that had he known as much early in the season as he does now, he could have saved his crops of wheat and corn. Some locusts also lit down here on their flight south.

To-day at ten o'clock the locusts were again flying northwest, but without much vigor. At two o'clock they seemed to be moving in an extremely high current in an opposite direction. The people much confused in their statements and quite contradictory. Observed the cow-birds to-day picking up locusts, and the yellow-heads at work among those that were flying at some elevation overhead. Birds generally much more abundant than when I was here in former years. This is probably owing to the increased number of groves and the cessation of the cruel habit of shooting birds.

Ponca, Thursday, July 26, 1877.—Reached here to-day at four o'clock. On the way up the locusts were moving in two opposite directions. On the lower current the locusts were moving a little east of north in considerable numbers. Above this current large numbers were moving a little west of south. At the edge where these two currents come together they seemed to intermingle. Crops looked grand all the way up. Locusts had here mostly died off.

Ponca, Monday, July 30, 1877.—Visited the so-called volcano to-day, 12 miles northwest of Ponca and near Ionia. On our way the locusts in considerable numbers were moving a little east of north. The crops in the county splendid. Locusts died off before destroying many fields.

Ponca, Dixon County, July 31, 1877.—Temperature 72° F. When we emerged to-day near noon from the timber at the mouth of Ionia Creek, where we had gone to visit some rock-exposures of the Cretaceous age, a considerable number of locusts were flying about 20° east of north. In the afternoon, very high up in the air, many were flying south.

Dakota City, Thursday, August 2, 1877.—Came from Ponca to-day by car. Locusts were again in the air, but moving aimlessly about, sometimes in a circle. Moving in a circle, I could not tell the numbers or even guess at the comparative number. Air comparatively calm, though slightly from the south.

Dakota City, Saturday, August 4, 1877.—A few locusts again moving a little east of north to-day.

Came to George Leamer's last night. His crops were threatened with destruction in the spring from the number of locusts on his farm; but they died off or disappeared in a mysterious way. Occasionally he found dead ones around his fields. He also thinks the birds destroyed large numbers of them. His farm is two miles west of Dakota.

Yankton, Dak., Monday, August 6, 1877.—Reached here this evening at five. On our way up from Sioux City, on the Dakota Southern, between Elk Point and Sioux City, the locusts were moving in two opposite directions. The lower current was moving a little east of north in considerable numbers. An equally heavy column was moving toward the south, above the one last mentioned. If there was any difference in numbers, the last was the heaviest in numbers.

This whole section between Sioux City and Yankton had been locust-eaten. Some fields every few miles gave evidence of the numbers and destructive work of the locusts. Settlers on the route assured me that where crops were produced the locusts died off; that only in a few places did the farmers fight them and destroy them with ditches and kerosene-pans. Where crops escaped the locusts they were good.

Niobrara, Knox County, Tuesday, August 7, 1877.—Yesterday evening, at five, took the steamer Black Hills and came up the river through the night, and landed here at five o'clock this morning.

Mr. Westover, in his team, took me up the Niobrara River ten miles. Temperature, 77° F. Locusts moving in large numbers to-day toward the south from 10 a. m. to 2 p. m. Velocity, 6 miles an hour. Height, $\frac{4}{5}$ mile.

Niobrara, Knox County, Wednesday, August 8, 1877.—Crossed into Dakota Territory to-day and went a great distance toward the northeast. Locusts in large numbers, high up in the air, were moving south; were moving south all the way on our return, and when we again reached Niobrara were still going south. Velocity of movement, 6 miles per hour.

Niobrara, Knox County, August 9, 1877.—Mr. Fry accompanied me to-day to the Bazile Creek, which we ascended some distance. Locusts were moving again in small numbers toward the south to-day, but not in such numbers as during the last few days. Velocity, 4 miles an hour.

On the Missouri bottom, opposite Yankton, the locusts had been very bad in the spring and early summer. Some fields of wheat they entirely destroyed. On other tracts they simply died off, so the farmers report. Some of the farmers here saved themselves by ditching and kerosene-pans, but these methods were not employed to any considerable extent. Where the crops were saved or left undisturbed they look magnificent. A few more locusts were flying south to-day. In some places on this long journey they seemed to be confused, and were flying around in all directions. I looked diligently and inquired of Buckwalters, Wynns, &c., for locust-data, but found none.

Dakota City, Saturday, August 11, 1877.—This morning started at Yankton, Dak., at 6 o'clock, and reached Sioux City at 12.

At 10 o'clock in Dakota Territory, between Vermillion and Elk Point, a great many locusts were moving south. The column, though sparse, must have been nearly a mile high. They were still moving south at Sioux City, and continued until about 3 o'clock. I saw the column decline as I was approaching this place, after I had crossed the Missouri. I saw a few fall down all along from this moving column, but could get none until I reached Sioux City. A few here that I picked up contained the small maggot before mentioned, and a few the red mites around the base of their wings.

Since I left Dakota City the people here report the locusts as having been moving south on the 7th, 8th, and 9th, the same days that they were moving south over Niobrara.

Dakota City, Sunday, August 12, 1877.—A few locusts were flying south to-day, but not to compare in numbers with the moving column yesterday. Velocity, about $5\frac{1}{2}$ miles an hour.

Omaha, Monday, August 13, 1877.—To-day, as I was coming from Sioux City, Iowa, to Council Bluffs, between 1 and 4 o'clock p. m., a few locusts were moving slightly west of south. Some others in places seemed to be confused, and were flying around in every direction. At Onawa, Iowa, I was told that the locusts that had lit down there on the 7th, 8th, and 9th of August from the north, going south, mostly left on the 10th and went toward the north, the direction from which they had come. The gentleman who gave me the information when he came on the cars at Onawa gave me his name as H. S. Perser. I have some doubts about his story.

Lincoln, Thursday, August 16, 1877.—On my way home from Omaha to-day saw a few locusts flying, but was not sure in what direction they were trying to go. They seemed to be moving high up in the air in every direction. An unusual number of dead ones were falling down from among the flying locusts. Many that fell were at first able to move around a few inches or feet, but soon lost motion and life. Many of these I could find nothing on—no parasites and nothing else. Up to this time found no traces of them pairing or getting ready for laying eggs.

MISCELLANEOUS DATA FROM CORRESPONDENTS.

FALLS CITY, RICHARDSON COUNTY.—I have lived here on the same 80 acres of land since the fall of 1865, and have kept a journal all the time, so the data I give are not from memory, but from records. We have seen the locusts come in here five times, and at present the fifth swarm is being hatched. The first time we ever saw them they came in large numbers from the west, on September 7, 1866, and consequently the first hatch here was in the spring of 1867; the season was wet and the eggs hatched late, as they are doing now, and I think there were quite as many here then as now. Nearly all the wheat, oats, potatoes, and garden-vegetables were ruined, except pease, which were not injured; the corn, which was thinned out in places by them before they left, made a good crop. In 1867 the first swarm that hatched here began leaving on June 28, and kept leaving, flying north and northwest, every day when the weather was suitable, so that on the 4th of July but few were left here. They came back again from the north in large numbers, but not so many as the year before.

In the spring of 1868 they hatched out early, so that they began leaving June 20, but they were not numerous enough to do us any serious damage. In the fall of 1868 a swarm came back, but smaller than either of the others, and our crops suffered but little from the young in the spring of 1869. From the time that swarm left we were not visited again till August 9, 1874, when the swarm came in from the southwest that we shall always remember. [Those hatched from] the eggs laid by them caused a total destruction of crops the next spring, and as a consequence nearly one-half of the farms in this county are mortgaged to-day.

In 1875 a great many hatched on a south slope on the 19th of April. The weather was dry, and almost every egg seemed to hatch. By the latter part of May almost every farm in the two counties, Nemaha and Richardson, was as bare as in mid-winter. After killing 200 apple trees for me, they began to leave on the 11th of June. Then we planted our corn again, but when it came up it was destroyed by a flying swarm that came down in a shower of rain.

Last fall the 'hoppers did not get here till September 14; they had been near, both north and west, for several weeks, but a steady south wind kept them back; so there were not as many eggs laid as in 1874. * * * The eggs were most numerously hatching this year (1877) May 8.—[George Hutchings.

SUNLIGHT, CASS COUNTY.—(Answer to question 1, circular 1.)—Arrived at 2 p. m. 26th July, 1874. Wind from northwest, light, breezy; clear; direction of movement to southeast, in clouds, low, flying and alighting all evening.

In 1875 first saw flying ones 11 a. m. 3d of June—most on the 16th—from the south, moving to the north, they were not numerous on either day, and quite high.

In 1876, arrived 24th August, 10 a. m., with a light breeze from northwest, moving southeast; but few quite high; following day alighted thick; weather clear.

In 1874, swarm departed September 4, to southeast; all got away that day.

In 1875, flew northwest and north from 3d to last of June, very thick on 16th.—[T. N. Babbitt.

PLATTSMOUTH, CASS COUNTY.—The locust eggs have been hatching with us ever since early in April, and are still doing so in shaded cooler places, as also where turned under by the plow and less exposed to the heat of the sun. A few warm days in succession have repeatedly covered the ground with the newly-hatched insects. But one peculiarity has been observed and generally commented upon by all observers, viz: but a very small per cent. of the insects increase in size. They are still small, as though but just hatched; and further, each successive hatching did not seem to increase the sum total, and very few are occasionally seen of from one-half to three-quarters grown; while it is time (with former experience) that the early-hatching should have wings and be arriving at full growth, as the small swarm from the south yesterday also indicates.—[A. L. Child, M. D., June 7, 1877.

GRAND ISLAND, HALL COUNTY.—According to my memorandum-book of previous years, the grasshoppers have visited this section of Nebraska, as follows, viz: while we settled in this county (Hall) in July, 1857, we did not notice any grasshoppers until in August, 1862. The first swarm appeared then and came with northwest wind; weather clear.

On the 1st day of August, 1864, the 'hoppers made their appearance again.

On July 15, 1865, all buckwheat in the county was destroyed by them, but no other crops.

On July 8, 1866, grasshoppers came in large swarms without doing a great deal of harm; northwest wind brought them; weather clear.

In the season of 1868, grasshoppers appeared again, but did no damage.

In 1869, grasshoppers came in the early days of August, and destroyed nearly all corn-crops in Hall County.

In 1873, on May 22, grasshoppers came in large swarms with southwest wind, damage light. They left with southwest wind, but on July 20th, 21st, and 22d, and on August 5th and 6th, in 1874, grasshoppers came in swarms, which at times darkened

the sun; wind north and northwest; weather clear. Nearly all the crops, in particular, corn-crops in Hall county were destroyed; but hardly any eggs were deposited by them here. They left before depositing their eggs and went into the southeast part of Nebraska, into Kansas, Missouri, and Iowa.

In the year 1875, grasshoppers appeared again in this county, June 24, with southwest wind, and on August 8 and 10 with northwest wind, and the damage in August was considerable. The greater number of them in 1875 were diseased and fell dead frequently when flying. Maggots, numbering from one to eleven in each 'hopper, were feeding on them within their bodies. Also little red parasites were frequently noticed fastened to their wings or bodies.

In the year 1866, the first swarm of grasshoppers arrived here on August 5, at 3 o'clock p. m., with northwest wind; weather clear. This swarm was not very large. On August 10 and 12, at m., large swarms arrived with northwest wind, and after a few days (August 13 and 14) commenced depositing their eggs. On the 14th some left, but at the same time more and still larger swarms arrived; weather clear and northwest wind prevailing. I worked hard with ten hands for ten days to save my corn-crop, vegetable-garden, and orchard, by smudging fires, adding freely pulverized sulphur, but eventually had to abandon one field after another, thus leaving the 'hoppers the victors. They stripped every fruit-tree of its foliage and took even the bark of the large limbs. Fortunately the small grain crops were nearly all secured in our county before the grasshoppers came, thus confining the damage done to corn-crops, vegetable-gardens, and orchards.

The 'hoppers continued depositing their eggs until the 23d and 24th days of August, 1876, when the wind, which ever since the 15th of August had blown from the south and southwest, changed again to the north and northwest, which carried all those which were able to fly south and southeast. The extent of country devastated by them, coming from north and northwest, reached from about the western boundary-line of Nebraska to the Missouri as far south as the State of Nebraska is concerned, and from the Platte bottom toward the northern boundary of the State, while farmers twenty-five miles south of here got fair corn-crops, on account of the grasshopers reaching them from ten to fourteen days later than us, in large swarms.

Of fruit-trees they relished the foliage of apple trees more than the foliage of crab apple, pear, peach, cherry, or plum trees; still all were more or less damaged, while plum and crab-apple trees were damaged least. Of forest trees the coffee-bean tree, box-elder, soft maple, honey locust, elm, beech, willow, Rocky Mountain evergreens, red and white cedar, were injured and eaten by them but little, while black locust, white or gray willow, white ash, catalpa, cottonwood, silver poplar, black and white walnut, European larch, American larch, Scotch pines, white pine, and Norway spruce, were eaten off and injured a great deal more than those trees enumerated first. Grape-vines, the cultivated as well as the wild were let alone until the apple trees were all stripped.

The native grasses were injured but very little, while timothy, blue-grass, red-top, and clover were eaten off clean by the full-grown 'hoppers.—[Wm. Stolly.

Hooper, Dodge County.—The first time I noticed the Rocky Mountain locust in this locality was June or July, 1859. They have since then, up to the year 1876, made short visits, never doing any damage to crops, nor did they at any time leave any eggs behind them. About the middle of September of the year last mentioned they came upon us from the northwest in full force. * * *

In 1876, wind northwest, fresh breeze, the first swarm arrived here, August 15, four p. m; clear, warm, with occasional flying dark clouds. The swarms were seen for three hours in the distance, mistaken by some for banks of clouds.

(Answer to question 2.) In 1876, on every dry day, when the wind was favorable from the northwest or west for some ten days, swarms were leaving each day to the south and southeast, others arriving from the west and northwest, and after, for two weeks longer deposited their eggs and leaving as soon as the job was done. Those which are hatched to the north have uniformly gone to the southeast, while the eggs which these deposited, when hatched, as uniformly move in the direction the parents came from.

The *Caloptenus spretus* has such a spread of gauzy wings that they can neither fly when the air is damp nor against the wind; they rise only when the dew is off, 10–11 a. m. to 4–5 p. m., and with no wind move about five miles an hour, or faster with the breeze, and high or low as the air is more or less dry, and highest at noon. * *

(Answer to question 10.) A period of not less than ten days will elapse after full wings are grown, to all appearance, before they will actually marshal their hosts, which will bring it, as in 1867 and 1874, to the last days in June, and before which there is no hope of being rid of them in this locality.—[C. F. Eiseley, May 14, 1877.

Farmer's Valley, Hamilton County.—The young insects have not been noticed to travel any particular direction. Having eaten a field of wheat, they have moved north on one field, while on another they have moved south. They do not seem to be governed by the points of the compass in their marching. The insects dropped on us July 21, 1874, about 3 p. m., wind from the northeast, and destroyed all crops but small grain, but departed July 31, 1874, about 11 a. m., wind northwest.

Birds have destroyed many of the young insects this spring. Blackbirds, being so numerous, already have the thanks of the country for the very great benefit they conferred upon us. Domestic fowls, prairie chickens, blackbirds, and quails partake of the eggs as well as the insects.

In the fall of 1874, the country was surprised to see numbers of small grasshoppers. The young insects were killed by cold weather that fall. We have not noticed any plants that the young eat but what the full-grown like as well. When they were here in 1874, they first eat the corn nearest maturity, whereas in 1876 they only injured the earliest corn, while they eat the latest. Their taste seems to differ with the times. Wild buckwheat is a great favorite with them, while they are partial to onions, cabbages, carrots, beans, asparagus, parsnips, and most garden-vegetables. Pease seem to be as little relished as anything they reject. Never been any injury to grass here. Besides birds, snakes, frogs, and toads eat the insects. They will eat, when full-grown, during the night. I had a field of corn in 1874 that was standing and not seriously damaged when night commenced. The next morning it was only corn-stalks, leaves and ears having been eaten as early as daybreak. When the insects drop upon us they remain only as long as the wind is unfavorable to take them upon their apparently desired course; as soon as it changes to suit they depart.—[J. Vosburgh, May 24, 1877.

Fremont, Dodge County.—Have not had eggs hatch here in the fall. In 1873 the Texas 'hopper deposited eggs here in June; these hatched in about two weeks, I think.—[G. F. Blanchard, May 11, 1877.

Friend, Saline County.—The time that swarms arrive varies in accordance to adverse winds to their general course. In 1873, the locusts, in passing from the northeast, encountered a southwest wind, which caused them to alight in great numbers, August 27, at about 4 p. m. On the following day, the wind having changed to the north, a considerable number of them passed on toward the southwest. In 1876, their first appearance was August 25, at 3 p. m. They came from the northwest, the wind being favorable to their general course. They evinced no inclination to migrate further, but deposited their eggs and remained till cold finally put a stop to their existence. Their descent has been either during clear, warm days, or upon the approach of sudden storms. The general direction of swarms is alternately from north to south, going south, where they deposit their eggs, and when the young are sufficiently large to fly going north the next season. The departure varies according to the amount of dew on the ground; when there is no dew on the ground their departure will date as early as 7 to 8 a. m. They always fly with the wind, and in case the wind is adverse they patiently wait for a favorable breeze.

This section was visted in 1858, 1874, and 1876. During the fall of 1876 my garden, 50 by 150, was literally filled with eggs, At that time I had seven common chickens, and I noticed that they were scratching up the ground. For two or three mornings after that I raked up one square rod with a garden rake, and by this time the fowls understood the business well enough to need no further assistance, and in this manner went over the entire plat. This spring I have kept close watch, but not to exceed a dozen young insects have hatched.

Pease and sweet-potatoes are the least relished by both old and young. Native grasses have not been injured to a degree to be visible.—[E. Whitcomb, June 1, 1877.

Pleasant Hill, Saline County.—In 1874 they came in from the northwest about August 10. The season was exceedingly hot and dry, the thermometer reaching 114 in the shade. The locusts were very ravenous, eating everything before them, but deposited eggs sparingly. Last fall they ate but little, but deposited eggs in enormous quantities, in many places as many as three hundred to the square inch.

All domestic fowls eat them in vast quantities; our little chickens just hatched live on the young ones without other food. All wild birds prey upon them, especially the prairie-chickens and quails. It is believed that a prairie-chicken eats one pint per day; quails about half that quantity. The birds which have done the best service is a black bird with yellowish-white head and wings; never noticed them here until this season. They came in great quantities, probably a thousand in a flock. They marched over the field like a band of soldiers, cleaning the ground clean where it was actually black with the 'hoppers. On a pasture-field of about eighteen acres they probably destroyed about five bushels a day.

The young insects are quiet during the night, crawling under old rubbish and into the ground. The full-fledged collect on shrubs and trees in quantities sufficient sometimes to bend the trees. When on the wing, I think they fly night and day. In June and July, 1875, there was an uninterrupted flight about fifty days, moving continually in a northerly and westerly direction.—[E. S. Abbott, May 21, 1877.

North Platte, Lincoln County.—The *Caloptenus spretus* are passing this place since the 27th instant, going north 30° west, in immense numbers. They are very high, 1,000 to 3,000 feet; only a few have stopped here.

In 1873 saw a swarm, July 6, in latitude 42°, longitude 100° 15′ west, passing southeast, but saw none in the settled part of the State.

In 1874 they came from northwest June 27 to August 6; then traveled northwest to October 3, but did no damage in this locality.

In 1875, May 20, latitude 42, longitude 103; saw a large swarm going north 30° west; June 6, at Camp Sheridan, saw them every day until 10th go northwest; June 21, latitude 41° 30′ north, longitude 101° west, saw them go southeast; continued to go southeast each day when the wind was favorable until August 5, when they began to go southwest, and continued until October 1. This is the first season that they have done much damage here. They took all the crops. They lodged against the snowy range of the Rocky Mountains in immense numbers and perished in the snow; a friend of mine says they were six inches deep on the snow.

1876, June 20, flew southeast to July 25, then drifted every way the balance of the season; did but little damage west of longitude 100° 30′. Laid their eggs south of latitude 41° from Colorado, at least east to 100 meridian; none north of this line.—[J. W. La Munyon, June 1, 1877.

Chapman, Merrick County.—Our section was most severely visited in 1876. Was visited in 1873, about the 15th May; did considerable damage to wheat, the only crop we had at that date; staid about 48 hours; weather cool and damp while they stopped; traveled from southwest to northeast. Was visited again in 1874, in wheat harvest, probably July 15; came from northwest, stopped about ten days, and left for southwest. Again in 1875, when corn was waist-high, probably June 25, but not so many as in 1874; they came from the south; stopped from three to five days, and left to the north, returning again from the northwest about the 20th of August, injuring the corn bad and destroying late corn entirely, and left in a few days without depositing any eggs. There were no eggs deposited in any of the above visitations (I speak only of Merrick County). They always travel with the wind, that is, the same direction. On nearly a calm day they travel as fast as the wind, but when the wind is strong they right about face, letting the wind carry them, but do not travel as fast as the wind. They always stop when the wind changes.—[H. M. Cox, May 18, 1877.

Albion, Boone County.—Since the settlement of Boone County there has never been any deposit of grasshopper eggs in the county. We have had considerable experience with grasshoppers during the migrating season in previous years. We have been visited by the flying locusts four out of the last five years. In 1874 they were flying in a southerly direction; the next year (1875) they were flying in the opposite direction, toward the north; in 1876 it was again reversed and they returned south.

My observations of their movements and habits in the years I have named have led me to the following conclusions:

First. That they fly north and south (or nearly in that direction) in alternate years, over this section of country.

Second. That there is no particular time of day in which they alight or rise, depending entirely and absolutely on the course of the wind, either favorable or unfavorable for the course which they are moving. I have seen fields literally covered with them in almost all kinds of weather, clear, cloudy, and rainy. I have seen them flying very thick just before a heavy shower and immediately after it, and yet did not come down, which has suggested the idea that they may rise above the rain during that time; if not, they must certainly fly through it.

In 1874 and 1876 they were moving from north to south, destroying our crops each year in consequence of the almost continued south wind detaining them, sometimes a week at a time. In 1875 they were fully as numerous and commenced their ravages fully as often as in either of the other years mentioned, yet the wind being favorable nearly all the time for flight in the direction they were going, their stay was very short at all times during the season. I have never known them to alight while a favorable wind was blowing, neither have I ever known them to remain an hour after a favorable wind commenced blowing.—[Loran Clark, May 17, 1877.

Ogalalla, Keith County.—Swarms were observed passing northward over this place 26th, 27th, and 28th of May; they were flying high. Large swarms have never stopped long in this section. No farming here.—[W. P. P. St. Clair, June 13, 1877.

Genoa, Platte County.—Movements of the locusts for the past month have been as follows: From 5th to 13th, the flight was to the north; from 21st to 25th, in the same direction; on the 29th commenced going south and descended in considerable numbers, but on 30th went north; on the 31st they again went south and southwest.—[George S. Truman, August 1, 1877.

Ponca, Dixon County.—August 9, 1872, the 'hoppers (a small flight) came down upon us, remaining about 3½ days, doing very little damage.

May 28, 1873, about noon, we were visited by any amount of Mormon grasshoppers. They went to work immediately depositing their eggs, doing but little damage to vegetation. June 5, 'hoppers about all left to-day. On July 17, 1874, was our terrible suffering. Legions came upon us, destroying our entire crop of corn, potatoes, cabbages, and all gardens, without exception. Everything they could light on was covered; sheds, trees, and the earth could not be seen for them. On July 21 they left. August 6, 1876, millions of 'hoppers lit down upon us.—[James Rockwell.

LOCUST RECORD KEPT BY HON. J. STERLING MORTON, NEAR NEBRASKA CITY.

1877.

February 17.—Weather beautiful. Locust eggs all seem to be good. One bottleful hatched out since Sunday.

March 24.—Locust eggs commenced to hatch out to-day on southern exposures.

March 30.—Many gardens made and many locusts hatching to get away with them.

April 12.—Locusts beginning to make their appearance in large numbers.

April 16.—Some farmers already report some damage done by the locusts, of which there are many.

April 17.—Great rain-storm last night. Locusts apparently unhurt.

April 19.—Rain all day yesterday and last night.

April 21.—Locusts hatching out rapidly. Temperature 70° F.

April 23.—Locusts getting thicker every day.

April 24.—Locusts hatching out very fast.

April 27.—Snow-storm to-day.

April 28.—Locusts unhurt; taken from under the snow not hurt, but appetite not good.

April 29.—This morning at 2, temperature 33° F. Ice formed by morning. Fruit not hurt.

May 1.—Tried coal-tar successfully in trapping locusts.

May 2.—Thermometer 83° in the shade. Rain last night. Locusts appear lively.

May 4.—Slight frost last night.

May 7.—Heavy rain last night again. Locusts appear dormant, but alive.

May 8.—Locusts hatched out more rapidly to-day than on any previous day. Very warm and pleasant.

May 9.—Locusts still hatching out fast, but no harm done as yet.

May 10.—Soaking rain to-day, and the ground very wet.

May 11.—Soaking rain continued all day long.

May 12.—Rain still continues. This is the greatest rain-fall for years. Earth completely soaked.

May 14.—Rained all yesterday and to-day, and yet after the rain the locusts hatched out in great numbers. Thermometer 75° to 80° F.

May 16.—Locusts disappeared in many places. In Armstrong's pasture saw many dead ones.

May 17.—Rained hard again to-day.

May 18.—Noticed no locusts for several days. Don't know what became of them, unless they died.

May 19.—Saw no locusts to-day.

May 21.—Locusts appearing again; getting thicker all around. They are also getting back their appetites. I hear that they are specially bad in the Weeping Water Valley.

May 22.—Locusts attracting much attention. They do not appear to grow any, and do not now hurt us any. Rain last night.

May 23.—Rained hard last night.

May 24.—Locusts hatching, but doing no hurt. No big ones to be found.

May 25.—Locusts still getting more numerous, but we are not yet hurt, and less scared.

May 26.—Locusts very numerous, but doing us no harm. Some farmers report their wheat partially eaten.

May 2 .—Locusts very numerous and growing some, but doing no damage.

May 30.—Locusts still with us, and growing fast in size and in numbers.

May 31.—Rained hard last night, and I could not plow to-day.

June 4.—To-day in plowing up locust eggs that we had plowed down in the fall they hatched out in four minutes after they came to the surface. I fear again that we will be hurt.

June 6.—Locusts thick in and around my clover field. Wind and rain-storm to-night.

June 7.—Locusts very thick and threaten destruction, though little damage is yet done.

June 9.—Locusts eating potatoes and clover. Chilly this evening. Locusts threatening.

June 11.—Several showers to-day. Using tar-pans.

June 12.—Eating more than before. Aughey and Thomas here this evening after the rain and wind at 4 p. m.

June 13.—Locusts thick and growing, but without appetite.

June 14.—Locusts thick, and their appetite improving.

June 15.—Locusts getting more numerous. This morning many winged ones that must have come here last night, as they were reported lighting down yesterday evening from the south.

June 16.—Weather very warm and the locusts moving about very much.

June 18.—Warmest day of the season. Thermometer 92° in the shade. Rained hard.

June 19.—Sultry and hot.

June 20.—Heaviest wind-storm of the year.

June 21.—Locusts thicker than ever before. Have wings and fly around. Rained and blowed hard last night.

June 22.—Locusts though thick are doing no harm.

June 23.—Locusts doing no damage. Rained hard to-night; thundered and lightened.

June 25.—Many locusts found dead to-day. Red parasites were under their wings that probably killed them. Rain-storm was severe last night.

June 26.—Locusts sickly and doing no damage.

June 27.—Rained last night.

June 28.—Very warm and sultry. Rained hard last night and this morning.

June 29.—Warm, and corn looking finely. Rain as usual last night.

July 5.—Warmest day of the season; 98° F. in the shade.

July 13.—Locusts have left, as many as were able to fly. Went mostly a little east of north.

APPENDIX IX.

NARRATIVE OF THE FIRST JOURNEY MADE IN THE SUMMER OF 1877, BY A. S. PACKARD, JR.

The following notes of my journey in the locust area, especially in the Western Territories, and California and Oregon, comprise, first, my own observations, and second, the information taken down from the statements made to me personally by others whom I met in the course of my journey, and are transcribed from my diary.

May 24, 1877.—Left Salem, Mass., arriving in Saint Louis May 26th to attend the meeting of the Commission.

May 30.—Saw Prof. F. H. Snow, at Lawrence, Kans., who tells me that the young locusts (*Caloptenus spretus*) do not occur this year at Lawrence, but are common in the larva state at a point on the Kansas Pacific Railroad 10 miles west of Lawrence. At Topeka, Kans., the locust (*C. spretus*) in the second and third larval stages was common by the railroad, but were doing little damage. I was informed that many had been killed by the heavy rains at Brookville, Kans., the soil of true prairie land, the grass being high, no buffalo grass seen, although the prairie dog, antelope, and red leaf-cutting ant were abundant. The true plains appear to begin 40 miles west of Brookville.

May 31.—The locust (*C. spretus*) was not as common as the young of other *Calopteni*. It was most common in the second and third stage of the larva state; especially about farms, houses, and lawns. No *C. spretus* were seen along the Kansas Pacific Railroad from this point to Denver, though the young of other species were observed.

June 2.—In company with Mr. J. S. Stanger, editor of the Colorado Farmer, I visited the farm of A. H. Arnett, at Morrison, where young locusts (*C. spretus*) had hatched out abundantly in the spring, and some had even hatched out within a week, he said. Those that I saw were in the second and third larval stages, and were hopping about on the plains in the cacti, &c., next to the irrigating ditches protecting the wheat-fields. Mr. Arnett informed me that the young locusts were more feeble than ever before. He said that immense quantities of eggs were laid in the summer of 1876, but the fly (*Anthomyia?*) laid their eggs at the time the locusts were themselves ovipositing, the flies placing their nits on the egg of the locust; these hatching out in the spring would destroy the eggs. In his opinion, the parasites, together with the heavy cold rains late in April and early in May, must have destroyed the young. Mr. Arnett says that the locusts came from the north in 1864, and he contends that their progeny fly in a southwest direction over the Rocky Mountain Range. They fly, according to his observations, at the rate of six and a half miles a day. Mr. Arnett also gave me valuable information regarding the means of fighting the young locusts, and as a preventive remedy suggested planting wheat earlier than usual.

June 3.—I noticed on the plains about Sloan's Lake, just outside the city limits, the locust (*C. spretus*) very abundant in the second and third larval and first and second pupal stages, in schools, scattered over the plains. The second pupæ were just molting, their cast skins being frequently observed on the ground, especially in the grass, in shallow dry ditches. The larvæ in the second stage were scarce, and the locusts were mostly in the third larval and first pupal stages. Flies (*Anthomyia* and *Sarcophaga*) were seen in abundance flying about them, and resting on the ground. No mites were to be seen.

June 4.—At Greeley I saw Mr. Joseph Ramsay, who had just arrived from a point near Julesburg, Colo. He told me that at a point seven miles east of Julesburg he saw a high, flying swarm, a locust occasionally dropping down. They flew with the wind, from the south, in the afternoon of May 29. On May 30 he again saw them 17 miles west of Julesburg, at noon, flying high from the south. They were very numerous, extending as far as the eye could see. (This was evidently a return flight from Texas.) From Mr. J. Max Clark I received much new and valuable information. He said that the locusts hatched out by millions this spring, and that while 50 per cent. were killed by insects, maggots, grubs of beetles, and mites, what were left were mostly destroyed by the cold rain and snow which fell April 24, 26, and 27, which was heavier at Greeley than at Denver. In March he observed that the eggs were sound.

June 5.—In company with Mr. David Boyd I walked up the railroad to a point where the young locusts were abundant, the schools of larvæ in the third stage traveling in

a general southerly direction, and falling into the irrigating ditches. A small red wasp (*Larrada semirufa*) was busy killing the young; several were seen. I was told that in places northwest of Greeley the young are quite common. In the streets of the town I found a number of pupæ of *C. spretus* in the second stage.

June 6.—At Cheyenne no young locusts were observed, and Mr. A. C. Dobbin, the United States weather signal observer, informed me that none had been seen this spring. At Sherman (8,240 feet elevation) the thermometer was 56° F., and large snow banks lay near the railroad track. Two station-men tell me that no locusts breed here, as the peculiarly gravelly soil is too coarse for them to deposit their eggs, though locusts are seen passing over. No young locusts were seen by me between Sherman and Laramie City. At this place the thermometer stood at 62°. I was told that no locusts had been seen here since 1874, and that few, if any, breed here. The impression gains ground with me that the Rocky Mountain locusts breed rather in the warm, grassy valleys and river bottoms than the elevated plains proper, and that consequently in their flights they seek valleys and sunny slopes overlooking the valleys rather than the dry, elevated plains.

June 8.—Spent the day at Farmington, Utah, on the edge of the Great Salt Lake, where the young locusts were very abundant on the edge of a field of lucerne and on the edge of a field of wheat. Some had very recently hatched and seemed not to have molted; others were in the second larval stage; most, however, were in the third larval stage, but only one or two were in the first pupal stage. Mr. Haight, the owner of the farm, says the eggs were laid the last of September, 1876, in the field of lucerne; they came from due north, the wind being due north. The eggs hatched mostly May 1; a few in the middle of March, but they died, owing to the heavy spring rains. As in Colorado, few were seen away from the edges of the cultivated fields. In some places from twenty-five to seventy-five could be counted on a single square foot of ground in the beaten roadside between the field of lucerne and wheat. Toads were very thick and evidently were feeding on the young, though I made no direct observations in proof of this. The red-winged and sooty blackbird were also common among them.

June 9.—At Lake Point, 20 miles west of Salt Lake City, young *spretus* were seen, though very rarely, on the lower benches about the shores of the lake. Mr. A. L. Siler, of Ranch, a settlement situated 27 miles from the southern border of the Territory, tells me that none have been seen by him this year south of Salt Lake. He says that a fall of four or five inches of snow, if it does not lie on the ground more than two days, does not injure the young locusts in Southern Utah. He says that many are destroyed by parasites; that a black wasp attacked them. In selecting its breeding-grounds, the locust, he says, is very intelligent, selecting favorite, warm, and sunny breeding-sites. Those eggs laid in the southern exposures hatch two or three weeks earlier than those on the northern, but all arrive at maturity about the same time, and ordinary rains do not affect them materially. The progeny of those that come from the north for two years in succession flew in a northerly direction. Should these observations be substantiated by others, there may occur in certain years in Utah a northern return migration, much as in Texas and the Mississippi Valley northward to latitude 40°.

In Southern Utah they harvest the wheat from June 20 to July 20, when the locust arrive, too late, however, to do serious damage to the wheat crop. After the wheat is harvested, the farmers living beyond the rim of the Great Basin, raise a crop of corn. This is sometimes devoured by the newly arrived locusts, which eat the blades, silk, and ears. Pease are the last vegetable they eat. In 1869 he observed them defoliating apple-trees, eating first the tender leaves and then the older, tougher ones: they would eat either whole peaches, leaving only the stone, or eat half a peach, leaving the other half as smooth as if cut with a knife.

Mr. John L. Barfoot, custodian of the Salt Lake Museum, who has taken great pains to assist the Commission, tells me that the locust in 1876 was common in Salt Lake City and on the bench or old lake terrace back of the city, and laid their eggs in the trodden compact soil, rather than loose plowed land. The locusts, he says, prefer onions to any other crop; lucerne and young sorghum next. In Utah they do not use coal-oil in their ditches, but have used tarpaulins daubed with coal-tar.

June 11—Went from Salt Lake City to Franklin, Idaho Territory, over the Utah Northern railroad, which runs up Cache Valley, the "granary of Utah." Young locusts were very common at Ogden. Ten or fifteen miles above Ogden, the women were seen fighting grasshoppers with cloths and bags, waving them and thus driving the locusts from the borders of the fields of grain. Were coal-oil used in the wet ditches as in Colorado, much labor and money would be saved and the locusts more effectually destroyed.

Winged locusts were observed about 20 miles above Ogden flying southeasterly, the wind being light and northwest in its course. At Brigham I was told that winged locusts first appeared June 4, and at Franklin June 3. The bodies were soft, and the locusts had evidently just molted. In some places a third of the wheat crop had been devoured by the young. At one point I saw the young (pupæ) either walking or hopping in a southerly course. At Hampton, a good many were seen flying down the val-

ley in a southeasterly course, the wind being northwest. Mr. Moses Thatcher, the superintendent of the Utah Northern Railroad, informed me that there had been as much rain in Cache Valley in the spring as about Salt Lake, and that the locusts in Utah had hatched later and more irregularly than usual, still they were very destructive in Cache Valley, and on one occasion the cars were stopped by the young, their dead bodies greasing the track so that the wheels would not readily revolve. They were also nearly as destructive in Malade Valley, I was told by Mr. Haight.

Mr. Thatcher told me that in three settlements in Cache Valley the people drove the young locusts into dry ditches in which large holes were dug, these were filled with locusts and then buried; in this way, in the three settlements, 2,000 bushels of locusts had been destroyed during this season. At the present date, women and boys and girls could be seen near Franklin, brushing the locusts away from the wheat-fields.

At Franklin, Idaho Territory, the locusts were very thick and destructive, and the people seemed disheartened. I saw some young only recently hatched, while most were in the pupæ state, and many were winged. Thousands of the unfledged locusts could be seen covering the fences and sides of barns and houses.

Mr. Alexander Stalker, of Franklin, tells me that the parents of this swarm came from a point about 200 miles to the north, and that they have this spring been hatching out between Franklin and said locality (near the Montana line) northward. The swarm came early in September from a point a little east of north. The young locusts hatched this spring at irregular intervals, *i. e.*, "scattering."

A person told me that at Kaysville a piece of ground containing the eggs was covered a long time with water, but the young locusts hatched out eventually, not having been killed by the submergence.

The young locusts were observed in bands or schools, moving in a northeasterly course. Other schools moved southeast, according to the statement of another observer. It is the opinion of farmers in Utah as well as Colorado, with whom I conversed, that winter wheat stands the attacks of the young locusts best, as it gets tough before they are old enough to eat the blades readily. I advocated both in Colorado and Utah the sowing of winter wheat, and several farmers with whom I conversed acknowledged that this would be an important preventive measure, barring the liability in a climate like that of Colorado and Utah of the crop to be cut off by severe cold.

June 12.—Started from Franklin in the overland stage to Virginia City, Mont. Young locusts (both larvæ and papæ) were observed in abundance along the road, but about the shores of Market Lake were exceedingly numerous, the soil being light and sandy.

June 13.—Locusts were observed all along the road as far as Snake River Bridge (or Taylor's Bridge), where they were abundant and winged. I was told by Mr. Wood, of Missouri, a fellow-traveler, that he saw a large swarm of locusts near Camas Creek (north of Market Lake), July 20, 1876, flying in a direction south of east.

June 14.—Crossed the "divide" into Montana early in the morning, in a snow-storm, several inches of snow falling on the hills near the stage-road. No locusts were seen on the divide or to the northward, though I walked two miles through the Beaver Head Cañon in places where they would be likely to occur, and it was warm and pleasant, with a bright afternoon sun. The rains had been very heavy all the past month.

June 15.—Reached Virginia City without having been able to detect any locusts along the road from the Rocky Mountain divide to this point.

June 16.—Spent the day at the toll-house, three miles from Virginia City, on the Bozeman road. Though I was walking about all day in search of the locust and other insects, not a single young or winged locust could be detected. I was also told by residents of Virginia City that there were no locusts this spring between the divide and this point. (The information received from persons I met here will be found in the Chronological History of the Locust.)

June 17.—Rode by stage and wagons to Bozeman. Although a careful outlook was maintained for locusts, none were seen, and none reported by the drivers and ranchmen along the road, though valuable information about invasions in former years was obtained from residents at Sterling.

June 18.—Obtained much valuable information from several gentlemen in and about Bozeman, and from General Brisbin, United States Army, in command at Fort Ellis, which is recorded in the chapter entitled Chronological History. Several persons tell me that the locusts appeared at Bozeman and vicinity in 1876. They came from the northeast or east, over the Big Belt Mountains, and departed in a southeast direction in one case, but usually go southwest. It seems most probable that the swarms which appeared in Bozeman and neighboring regions of Montana did not lay their eggs there, but pushed on in a south or southwest course over the Rocky Mountain divide into Idaho, into the region between Cache Valley and Pleasant Valley, where I encountered their supposed progeny this summer in such numbers. The migration is invariably from the Yellowstone Valley over the Big Belt Mountains, and many persons told me that the swarms in their flight almost invariably, in crossing this elevated range, passed over the farms lying immediately at the base of the mountains, which thus in

each locust year enjoyed an immunity from their attacks. Dr. Lamme told me that the unfledged locusts travel southward, going in the same general course as the winged ones take afterward.

Mr. P. W. Macadow not only gave me important facts about former locust years in Montana, but informed me that he had that day been told by Messrs. Malin and John Johnson, who had just arrived from the Yellowstone Valley from Baker's battle-ground, that locusts were reported as having hatched out in great numbers there, and all the way from Froze-to-Death Creek to Baker's battle-ground, near the mouth of Clark's Fork, on the north bank of the Yellowstone River, in the Bad Lands. This tract of country is about ninety miles in length, and the western limits of the area lie about one hundred miles due east of Fort Ellis, Mont. Between this point and Fort Ellis none were observed by Messrs. Malin and Johnson. I was informed, however, by General Brisbin, that unfledged locusts were observed this spring by several Army officers who were fishing at a point 18 miles east of Fort Ellis over the Big Belt Mountains. This locality was on the Yellowstone River, just east of the mouth of Shields River. Mr. Macfarlane also informed me that he saw no locusts this spring in the region lying between Yellowstone River, near the Crow agency, and Summit Creek, which empties into the Musselshell River, a region about 30 miles in extent. (From these data, and taking into account the universally western course taken by the swarms from the Upper Yellowstone Valley, it is most probable that the locusts which appeared about Bozeman and Gallatin City late in the summer of 1877 came from the vicinity of Baker's battle-ground.)

June 19.—Rode from Bozeman to Helena, without seeing any locusts by the way. None had hatched out this spring in the Jefferson, Gallatin, or Madison Valleys near where they unite to form the Missouri River.

June 20 *and* 21.—Examined the plains about Helena, without finding any locusts (*C. spretus.*)

June 22 *and* 23.—Saw no locusts along the road from Helena to Fort Benton, and found that none were seen by residents, though this region is nearly every year more or less devastated by them.

At Fort Benton, Mr. J. J. Healy, of Sun River Settlements, told me that locusts hatched at Fort McLeod (Fort McLeod is situated, in longitude 113° 35′, about 30 miles north of the United States boundary line, and about 180 miles northwest of Fort Benton) in February, 1877, the weather then being very warm, but the young were afterwards destroyed by the inclement weather.

Mr. James M. Arnoux, of Fort Benton, who has a ranch on Highwood Creek, gave me many valuable facts. The locust has appeared in the vicinity of Fort Benton and Highwood Creek, each year from 1873 to 1876. The young hatch out in April and May, and when winged fly in a southwesterly direction; the swarms always coming from the northeast, and departing in a southwesterly direction. In June and early in July, 1876, large swarms flew from the region lying between Fort Benton and a point 400 miles north in a due east course, an exception to the ordinary rule. From Belknap, a point in British America from 96 to 100 miles north of Fort Benton, and from the region about Fort Browning, 150 miles northeast of Fort Benton, all hatched out and flew at the end of June and early in July, 1876, toward the east; very heavy swarms having come from an easterly direction in 1875 and deposited their eggs.

Mr. J. J. Healy tells me that he saw locusts at Battle River in British America. This valley lies just south of and also upon the fifty-third parallel of latitude, and is the most northern point to which the locust has been traced. From his conversation and evident familiarity with the locust in Montana, I have little doubt but that the species he observed was *Caloptenus spretus.*

Mr. Arnoux also told me that the locusts in 1876 extended from 250 to 300 miles north by west, toward Fort Edmonton in British America (Fort Edmonton is on the North Saskatchewan River, and is a little west of the one hundred and thirteenth meridian; this is the Northernmost point of the locust area that I have been able to ascertain on this journey). Mr. Arnoux also stated that the greater number of locusts breed from eighty to one hundred miles north of Fort Benton. That snow does not always kill the unfledged locusts is shown by Mr. Arnoux's statement that May 24, 1876, there fell a foot of snow, but the young locusts were not destroyed.

Lieut. C. A. Booth, United States Army, of Fort Shaw, told me that he saw plenty of grasshoppers (? *C. spretus*) along the Yellowstone River in the summer of 1876, though they did not occur in swarms.

June 24.—Left Fort Benton in the steamer Red Cloud for Bismarck. Capt. W. R. Massie, in command of the steamer, told me that unfledged locusts were seen by him all the way between Bismarck and the Black Hills in June, 1876.

June 25.—No locusts were to be seen at any of the landing-places along the river.

June 26.—Passed Fort Peck at 5 a. m. and Wolf Point at 11.30 a. m. Mr. S. S. Hughes, acting Indian agent at Wolf Point, which is 45 miles in a straight line east from Fort Peck, stated that locusts hatched at Wolf Point the last of May, 1876, and that June 20, 1876, swarms of locusts came from the east. The present season large swarms, like masses of clouds, arrived June 18 from a point due east; some were seen on the

21st on the ground, having either dropped by the way or been forced back by the west wind; but none hatched in the vicinity of Fort Peck or Wolf Point this spring. The weather June 26th was cold and rainy, the wind being easterly. I was told by Mr. Hughes that a great deal of rain had fallen about the 1st of June at Wolf Point—more than for two months previous.

June 27.—Wind still east; cool and rainy. No locusts were seen at a point 20 miles above Fort Berthold. I was told that locusts were seen flying at the end of June or early in July, 1876, at Strawberry Island, 140 miles east of the Dakota State line, at Fort Buford. None were seen this year. They occurred at this point, sometimes in swarms, in 1873, 1874, and 1875.

Arrived at Bismarck at 11 a. m. Locusts were first seen at Bismarck June 21, 1877, early in the morning, having probably descended the afternoon or night previous; they came from the southeast, said my informant, Col. G. W. Sweet. Col. W. Thompson also told me that the locusts arrived here June 21 from a point almost directly southeast, the wind being southeast. They afterward departed in a southwesterly direction, beginning their flight about noon. He also said that July 1–5, 1876, myriads of locusts passed over Bismarck, in a southeasterly direction, toward Minnesota, having come off the plains about Bismarck. Colonel Thompson thinks that the locusts breed on the elevated, dry plains. The blackbird and "snowbird" destroy large numbers of locusts and nearly protect his crops. He also "fights" the winged locust by drawing ropes over the fields of wheat, to which brush is attached at intervals of four feet; and thus, by the aid of birds and the use of the brush, he is not afraid of losing his crops. He is decidedly of the opinion that in migrating the locusts if detained by a head wind wait for a fair one.

I observed on the afternoon of the day I arrived at Bismarck a few locusts (*C. spretus*) in the streets, and especially on the plains about the town. On opening the bodies of twenty females it was found that the eggs were not in any case ripe, but only developed one-third or one-half of their full size, indicating that the females would not lay their eggs probably for two or three weeks. One of the twenty females opened contained a maggot of Tachina, which had rendered her sterile, the eggs being undeveloped.

June 30.—Detained near Crystal Springs, a station on the Northern Pacific Railroad, over thirty hours by the heavy rains from the east, which caused heavy washouts. At this point I saw two or three locusts (*C. spretus*).

At Jamestown (Fort Seward) I was told that locusts flew over the settlement from the southeast June 18–20. A few only were seen.

A fellow-traveler, Mr. Davis, just in from the Black Hills, says that locusts were observed flying toward the west at Belle Fourche, and on the Spearfish River, in the Black Hills.

I observed that the true plains rather than the prairies extended from Bismarck to near the Red River of the North. What prairie-land I observed was confined to the river-bottoms. No locusts were heard of east of Jamestown. At midnight crossed the Red River into the wooded country of Minnesota.

July 1.—Arrived at Brainerd, crossing the Mississippi River at 6 a. m., and, July 5, reached Salem, Mass.

As the result of this journey the Commission were able to announce that there were no unfledged locusts in a very extensive region of the Northwest, comprising large portions of Montana, Dakota, and also British America for about 250 miles north of the Upper Missouri, a region bounded on the north by the North Saskatchewan River. As this region, together with the Yellowstone Valley, is usually the great breeding-ground of the Rocky Mountain locust, the Commission felt authorized, from the state of things there and in Wyoming and Colorado, to predict that there would be no invasion of the border States from Texas to Minnesota in the summer and autumn, which would necessarily insure an immunity from the attacks of young locusts, at least in 1878. It was also ascertained that in the tracts of country in Colorado, Utah, and Idaho, where eggs were laid the year previous, and unfledged locusts were observed in greater or less numbers, that the cold, heavy rains of April and May, and the parasites, had, as in the Mississippi border States, so materially reduced their numbers as to render them powerless to do material harm, except in Cache and Malade Valleys in Northern Utah, while serious local damage was committed by them in Bitter Root Valley, Montana. Besides this, much information regarding the occurrence of the locust in the territories visited and the northern limits of the locust in British America, was obtained either personally or from residents or travelers. It seems now probable that the locust ranges as far north as latitude 52° or 53°; in Battle River Valley, situated south of the North Saskatchewan River and in approximate longitude 109°–111°, and also near Fort Edmonton, which is situated on the North Saskatchewan, in latitude 53° 30′ and longitude 113° 40′ (approximate). Besides this, much information regarding the physical geography of the country traveled over was obtained, bearing especially on the nature of the breeding-grounds of the locust, which seem to be confined rather to the fertile river-bottoms and warm hill-sides overlooking them, than to the elevated, arid, cooler table-lands, where farms can perhaps never be maintained.

APPENDIX X.

NARRATIVE OF A SECOND JOURNEY MADE IN THE SUMMER OF 1877, BY A. S. PACKARD, JR.

August 6.—Left Salem, Mass., to attend the first Chicago meeting of the Commission, held August 8 and 9.

August 10.—At Schuyler, on the Union Pacific Railroad, the locust (*Caloptenus spretus*) was thick, rising in great numbers from the grass, being frightened by the cars; they flew vigorously, and had no appearance of being weary. They were common from this point to Richland, being in one locality very abundant. None were seen beyond this point.

August 11.—Breakfasted at Sidney, Nebr., at 5 a. m. I saw small sage-bushes (*Artemisia*), and we were evidently near the eastern limits of the plains, which is probably from 50 to 75 miles east of Sidney. At Pine Bluffs I saw a herder who said that no swarms of locusts had been seen there, only a few grasshoppers flying about the plains. At Cheyenne saw Mr. Dobbin, the United States weather-observer, who said that no locusts had been seen flying in that vicinity.

August 12.—At Echo City a good many thousand locusts (*C. spretus*) were seen flying in the air and resting on the ground. Those flying were observed to be moving eastward up the cañon with the gentle west wind, while there were others to be seen flying in an opposite course. It was very warm, the thermometer in the car being 88°. Myriads of them were seen in the grass toward the 1000-mile tree, but just before reaching the tree almost none were to be seen in the air or on the ground, showing how local the swarm was. At Weber, though there were extensive fields of wheat and oats, mostly, however, harvested, only one or two locusts were seen. None were observed at Ogden, where the young were so abundant in June, but two or three miles south of the town a few were seen along the Utah Central Railroad.

August 13.—No locusts in sufficient numbers to attract attention have been observed in or about Salt Lake City, as I was informed by the United States weather-observer, and by Mr. Balfoot, the curator of the Salt Lake museum. Dr. E. Palmer and Mr. A. L. Siler also told me that none had been observed by them in Central or Southern Utah.

August 14.—At Lake Point, 20 miles west of Salt Lake City, on the shores of Great Salt Lake, the locust (*C. spretus*) occurred in abundance, but not in much larger numbers than another species associated with it, in the moist land and tall grass bordering a field where wheat had been harvested, and which had been irrigated. None were seen pairing or laying eggs.

August 15.—Visited the American Fork Cañon, but found no locusts in the cañon, the only grasshopper being a species of *Œdipoda*. On my return, however, locusts (*C. spretus*) were seen flying about the edge of wheat-fields at Sandy, in much greater abundance than at Lake Point.

August 17.—While on the train I met Mr. C. C. Wheeler, of Cornucopia, Nev., who got on at Golconda, and who gave me some valuable data regarding the swarms of locusts which have this year for the first time in the knowledge of the settlers invaded the northern limits of Nevada and Southeastern Oregon. From his account the species could have been no other than *Caloptenus spretus*. He said that the locust was very abundant and destructive to crops in the Bruneau Valley, Idaho, southwest of Boise City. (I had previously heard that locusts had hatched out in abundance in the spring at Boise City.) The 2d of August they were observed at the upper or southwest portion of the Bruneau Valley. On the 5th and 6th of August, they appeared in Nevada, flying in great swarms, eating up the crops and filling a well in one locality, in the Owyhee Valley, seven miles northwest of Cornucopia, Nev. (Cornucopia is situated 30 miles south of the Idaho line.) Mr. Wheeler had never heard of them before and did not know where they came from. (It seems most probable that these locusts came from the Bruneau Valley, in the neighborhood of Boise City, the distance from Cornucopia to the Bruneau Valley being only about 100 miles in a northeast direction. Mr. Wheeler also said that the cricket (*Anabrus*) was very destructive in Northern Nevada. He observed them August 16 and 17 laying their eggs in the sand on the road between Cornucopia and Winnemucca. In 1876 they devoured about

three thousand dollars' worth of grain and wheat. At Winnemucca I was told that no locusts had ever appeared. None were seen at Humboldt Station this year, though in 1871 swarms of them were seen west of the station by Prof. Cyrus Thomas.

August 18.—At Reno I found *Caloptenus Atlanis* in small numbers in fields of alfalfa or in the tall grass bordering the fields, but never away from the damper, irrigated, more shaded grass-lands, never on the plains and on the roadsides, where the different species of *Œdipoda* abound. The pupa was very much like that of *Caloptenus spretus;* exactly, in its general style of coloration.

August 19.—At Glenbroke, Nev., on the eastern shore of Lake Tahoe, in hay-fields more or less damp, and in the stubble of wheat-fields, *C. Atlanis* occurred in abundance.

August 23.—Arrived yesterday at Berryvale, Sisson's Station, in the entrance to Shasta Valley. The insects of the woods and fields in their general appearance, as well as the vegetation, remind one of the forests of Maine. Here occurred *Caloptenus femur-rubrum* in great abundance, and every now and then *Caloptenus Atlanis*, associated with them in about the same proportion as in Maine and Massachusetts. Of the *C. Atlanis*, some were dark-colored exactly like *C. femur-rubrum*, while others were paler and much like *C. spretus* in their general appearance, though they were smaller, and with much shorter wings. *Caloptenus bivittatus* was not uncommon here, and was ovipositing, while *C. femur-rubrum* was observed *in copula*. As noticed in Utah and Nevada, the species of *Caloptenus* almost invariably affect damp grassy fields and gardens and mowed lands, while the species of *Œdipoda* almost invariably frequent the dry, hot, exposed road-sides and fields, where the grass was short and dried up.

August 25.—Ascended the crater-cone of Mount Shasta, and at and above the limits of trees spent several hours in turning over stones for insects without perceiving any traces of dead locusts (*C. spretus*) which are so commonly found on the peaks of the Rocky Mountains. This would indicate, although it might not prove, that swarms of locusts never pass from Nevada or Idaho over the Sierra Nevada.

August 30.—At Portland, Oreg., the common red-legged locust (*Coloptenus femur-rubrum*) which is the destructive species in the Atlantic States, was the most common form about the outskirts of the city, although a few *C. Atlanis* were associated with them, both locusts occurring in the same relative numbers as at Berryvale, near Mount Shasta. In fields near East Portland, while the red-legged locust was abundant, the *Atlanis* form was not to be found. In the same fields occurred in abundance a species of *Pezzotettix*, a locust with remarkably short wings, which bore a remarkable resemblance in color and markings to the red-legged locust, though differing in the form of the male genital armature. The hind tibiæ are bluish.

August 31.—At the cascades of the Columbia river the red-legged locust (*C. femur rubrum*) was common in company with *Œdipoda Carolina* on the grassy banks of the river at the lower railroad station.

September 2.—At Umatilla, Washington Territory, found in abundance in the sage and grease bushes *Caloptenus Atlanis* of a variety which approaches *Caloptenus spretus*, in its large size and length of wing. With them were associated a beautiful blue-legged *Caloptenus*, which was especially abundant, feeding on the grease-wood, there being no grass. This mixture of some of the characters of *C. spretus* with those of the species *Atlanis* were of great interest. It were as though *C. spretus* had at this point hybridized with *C. Atlanis*, resulting in forms which apparently showed that the two species had interbred. This would seem to be a possible view, since swarms of *C. spretus* have flown as far west as the vicinity of Walla Walla, which is only about 25 miles due east of Wallula. But I think the explanation of the cause of the tendency of *C. Atlanis* to (in this region) vary in the direction of *C. spretus*, the true Rocky Mountain locust, may be discovered in the climate, soil, rain-fall, and physical geography of the Columbia Valley east of the Cascade Range. In all respects it is a continuation of the alkali desert of Nevada, the region being, however, less elevated. The elevation of the Plains of the Columbia at Wallula and Walla Walla is only about 800 feet above the sea; the country is level, forming a sandy desert, broken up by ranges of mountains (such as the Blue Mountains) running nearly north and south, and in height and scenic features is like the mountain-ranges in Central Nevada, as observed along the line of the Union Pacific Railroad. The settlements are situated in oases in this desert. Walla Walla is situated at the base of the Blue Mountains, in the head-waters of the Walla Walla river; its elevation is 865 feet. There is no arable land at Wallula or Umatilla, nor westward until we reach Dalles, at the foot of the Cascade Mountains. There are no farms near Wallula, on the east, until we reach Walla Walla and Dayton, W. T. The rain-fall is very slight,* much as in Nevada, droughts being prolonged, and in

* The mean temperature for eight years from 1857 to 1864, inclusive, was 51° 5′. The extremes were lowest January 15 and 16, 1862, when the thermometer went down to 24°. The highest, 107°, on the 7th of August, 1860. The winters of 1856-'57 and of 1861-'62 were very severe. The mean annual rain fall for these eight years was 22.3 inches, but the fall was very irregular in amount, 50.66 inches having fallen in 1862, and but 4.06 inches in 1863. Little rain falls in June, July, August, and September. The prevailing winds are southwest and southeast. The changes in the temperature are very sudden.—[Hygiene of the United States Army, Washington, 1875, p. 491.

winter there is little, sometimes no snow falling, the moisture in the "chinook" or southwest winds blowing from the Pacific Ocean, is mostly absorbed by the Cascade Range, what is left falling on the Blue Mountains and the Bitter Root Mountains beyond. The Plains of the Columbia, owing to their slight elevation, and the presence of mountain-ranges on the east and west side, are very hot, the nights being hot as well as the days.

I have entered at some length into the description of this portion of the Plains of the Columbia because the Commission was unable to obtain from books or geographers any adequate idea of this region. I had supposed that the country was in its physical characteristics a western extension of the Rocky Mountain plateau, and in an unpublished map showing the distribution of the Rocky Mountain locust, prepared last year, I had ventured to extend its distribution west of the Rocky Mountains to the Plains of the Columbia. Even in making inquiries regarding the nature of this region in passing through Montana early in the summer, I was unable to elicit any exact information, except that the country was like that of the level portions of Montana, but I found that the rain-fall is much less, the heat probably greater, the winds dryer and hotter, and the soil absolutely incapable of maintaining a farming or grazing community except in the river-bottoms of the smaller streams. Here, then, we have a country which can only support the Rocky Mountain locusts in small quantities. Swarms may invade Walla Walla and Dayton and adjoining farming-regions, but their young would not have sufficient pasturage, they would die off, and when present on the farms could easily be stamped out. For this reason, as in Nevada, while swarms may occasionally appear, they will not gain a permament foothold on the Plains of the Columbia, east of the Blue Mountains at least.

To return to the subject of the peculiar variety of *Atlanis* found at Wallula, we have in its environment a great difference from the low, damp, temperate climate of Western Oregon, and these differences are sufficient to account for the difference between the normal form of *Atlanis* and the Wallula variety.*

At the Dalles no locusts of any sort, except a small grasshopper belonging to an unknown genus, were detected, as the hills and plains about the town were very dry and parched. The sage-bush and grease-wood are frequent on the hills, and it is evident that the flora and fauna of the Plains of the Columbia extend up to the foothills of the Cascade Range, and there is apparently no physical reason why the Rocky Mountain locust may not, under favorable conditions of winds and other circumstances, fly quite to the foothills of the Cascade Range, although I was unable to obtain any evidence that it has ever been seen west of Walla Walla.

I met here several persons who gave me important information regarding the invasion, last month, of the Rocky Mountain locust in eastern Oregon. Mr. Frank Loughgerty, of Clarksville, a settlement about 20 miles southeast of Baker City, told me that locusts appeared in swarms in the settlements in the Burnt River Valley. This settlement lies a few miles southeast of Baker City, in latitude 44° 45′, and about 20 miles west of the Snake River, which here forms a great bend to the westward. The locusts appeared in swarms in this region about the middle of August, coming from an easterly direction. They were very annoying, eating off the tops of onions and gnawing the bark of fruit-trees, especially the peach. Mr. Lougherty thought that the locusts would not advance much further west, as there was a barrier of mountains west of the settlements, forming a divide between Burnt and Powder Rivers. Mr. W. F. Gwinn, of Walla Walla, told me that the stage-driver on the route from Baker City to Walla Walla informed him that a swarm of locusts appeared in the Burnt River country about the 10th of July; that they "ate out three ranches," devouring the beet-tops and other vegetables. When seen they were traveling in the direction of Walla Walla, namely, in a northwest direction and from the southeast. This fact would indicate that these swarms of locusts came from Snake River Valley, about Boise City, where they are known to have hatched in large numbers.

September 6.—Arrived at Victoria, Vancouver Island, *en route* for San Francisco. On one of the Columbia River steamers I met Mr. J. K. Lum, of Skookumchuck, Wash., who gave me the only information I was able to obtain relative to the ravages of locusts in Washington Territory, west of the Cascade Range. He tells me that in August, 1876, grasshoppers were very abundant at Skookumchuck,† eating the heads of wheat, blackening the grain. He thinks the species was larger than the Rocky Mountain locust. It did no damage elsewhere.

At Victoria, Vancouver Island, a peculiar variety of *Caloptenus atlanis* occurred in abundance on the dry open fields about the shores of the Straits of Fuca, associated with *Œdipoda pellucida (atrox)*,‡ which was equally abundant; but in the damper fields

* This case may be parallel in some respect to that of *Colaptes Mexicanus* and *C. auratus*, the western and eastern yellow-hammer woodpecker.

† Skookumchuck is situated in Lewis County, Washington Territory, between Kalama and Olympia, the country being level and well wooded.

‡ I noticed that this species, which has been placed in a separate genus (*Camnula*), does not make a crackling noise like the species of *Œdipoda*. Along the shores of the Straits of Fuca *Œdipoda carolina* was common. I also captured it at Salt Lake City, Utah; Reno, Nev.; Shasta Valley, Cal. It is a common Pacific Coast form, and varies there much as in the Eastern States.

of taller grass bordering the wheat-fields, and in the old wheat-fields the *Caloptenus* was equally abundant. This variety of *Caloptenus* has been identified by Mr. Scudder as Walker's *Caloptenus bilituratus*, and I have also compared it with Walker's description. *Caloptenus bivittatus* also is a not uncommon Pacific Coast grasshopper. It occurred at the base of Mount Shasta, Sisson's Ranch.

September 16.—At San Francisco obtained such information from Messrs. Henry Edwards and James Behrens as to lead me to think with the observations that I have myself made that there is no reasonable doubt but that *Caloptenus atlanis* (and probably *C. femur-rubrum* which is often, as I have found, more abundant in some localities in central and northern California than *C. atlanis*), is the species which has locally devastated portions of California, though *Camnula pellucida* may occasionally become injurious.

September 20.—A diligent search in the Yosemite Valley as well as at the grounds about the Big Tree Station (Clark's) failed to reveal any traces of *C. atlanis;* none were seen on the mountains by the valley nor along the roads from Merced to the valley, only a few specimens of *Œdipoda*, which flourish by the roadsides and dry fields. There was no evidence found to give any grounds for the belief that swarms of the Rocky Mountain locusts have, or ever will, fly over the Sierra Nevada from Nevada or the region north.

September 21.—Thomas Birmingham, a guide at the Big Tree Station, told me that in the San Joaquin Valley in 1856 or 1857 the grasshoppers were very abundant and destructive, eating grains, vegetables, fruit-trees, flying in the face of the traveller, and thus proving annoying. In one case they eat a man's coat. They came in two separate swarms from the south in June and July, after the wheat-harvest was over. Thomas Givens, of Hornitos, told me that in that town in 1862 or 1863 a swarm of grasshoppers came from the south, like a white glistening cloud, in June or July. They were observed eating the bark of peach-trees. In April of the present year, young grasshoppers were very abundant near Hornitos, but the subsequent heat and drought destroyed the herbage, so that the grasshoppers disappeared. In 1856 or 1857 a swarm fifteen miles wide came from the north, and were so numerous as to fill a well at a locality known as the fifteen-mile house, near Stockton. Mr. W. L. Morton, of Tulare County, told me that in 1869 the grasshopper was abundant in that valley in 6th township, 18th east—21st, 6th east. They flew from the southwest, appearing for three weeks, from the last of May till the middle of June; they eat grape leaves, corn, and wheat. In September they were abundant at Stone Corral, township 16 south, 24 east.

September 23.—Mr. J. B. Sears, of Stockton, says that in the year 1858 (?), in the summer, the grasshoppers were abundant, eating garden-vegetables, especially onions, fruit, oak-leaves, &c., but came too late to injure the wheat-crop. Of a number of gentlemen whom I saw none knew of any destructive species of grasshopper in California, and I am inclined to think that the ravages committed by locusts in California at the present day are not of great moment, and are paralleled by the occasional damage done by swarms of the red-legged locusts *(Caloptenus femur-rubrum)* in the Atlantic States.

The results of this journey may be summed up as follows: Definite information was obtained concerning the invasion of Northern Nevada and Eastern Oregon by swarms of the genuine Rocky Mountain locust, and they were traced with a good degree of probability to the Snake River Valley, in the vicinity of Boise City. The western limits of the Rocky Mountain locust were definitely ascertained to be near the meridian of 120°, extending along this line from latitude 58° to 37°. It is most probable that while this locust may occasionally, in Washington Territory and Oregon, fly to the eastern flank of the Cascade Range, and in California as far as the eastern flanks of the Sierra Nevada, swarms never pass over those mountains.

The species sometimes destructive in Washington Territory and Oregon, in the forest region west of the Cascade Mountains, and in California, is *Caloptenus atlanis* and probably, also, in some localities, *C. femur-rubrum*, both abounding and sometimes destructive in the Atlantic States.

NOTE REGARDING VARIATIONS IN CALOPTENUS SPRETUS, ATLANIS, AND FEMUR-RUBRUM.

As *Caloptenus atlanis* and *femur-rubrum* occurred in abundance in Upper California, and the former in Oregon and Washington Territory and Vancouver Island, I have made the following comparisons between the specimens from different points in the Pacific States and individuals from the Atlantic States.

C. atlanis ♂ from Portland and Oregon compared.—While *atlanis* from Portland, Oreg., are normal, those from Wallula, in size and length of wing, approach *C. spretus*, though they still differ, the markings and colors being like *atlanis*.

Measurements.

C. spretus ♂, from Salt Lake, length of body and wings (folded), 31½, 33½; wings 23½, 25; hind femora, 13½mm.

C. atlanis, from Wallula, smallest ♂, length of body and wings (folded), 25; wings, 17½; hind femora, 13mm.

C. atlanis, from Wallula, largest ♂, length of body and wings (folded), 28; wings, 20; hind femora, 13½mm.

C. atlanis ♂, from Portland, Oreg., length of body and wings (folded), 24½–25; wings, 17; hind femora, 13½mm.

C. atlanis ♂ (*bilituratus*), Vancouver Island, length of body and wings (folded), 23; wings, 16; hind femora, 12½mm.

C. atlanis ♂, Shasta Valley, Cal., length of body and wings (folded), 21½–25mm.

C. atlanis ♂, Lake Tahoe, Nev., length of body and wings (folded), 22mm.

C atlanis ♂, Massachusetts, length of body and wings (folded), 24½mm.

In the male genital armor, especially the male cerci, the Wallula male *atlanis* approaches *C. spretus*, the cerci being shorter and broader than usual, and thus are like those of *C. spretus*. The environment of the Wallula *atlanis* is like that of *C. spretus*, and for this reason, probably, it approaches it more than a mountain form like that from Lake Tahoe, or the normal form like that at Portland, Oreg. The body of the Wallula *atlanis** is slender, but not light-colored as in *atlanis* from Redding and Shasta Valley, California, or Michigan, which closely resemble in coloration *C. spretus*. We have here at least a mixture of *spretus* with the genuine *atlanis* characters. (In one ♂ from Wallula the hind tibiæ are bluish; in all the others, red.)

In ♂ *C. atlanis* from Portland, Oreg., and Amherst and Essex County, Massachusetts, there are no differences in size and markings, or in the form of the hind femora, except that in some Oregon specimens the tip of the abdomen of the Oregon examples is in some cases higher and the notched portion rather narrower, but this difference is not to be seen in any other ♂ from Amherst, which is as high and narrow as in the Oregon one.

In ♂ *C. atlanis* from Portland, Oreg., and ♂ *C. atlanis* from Victoria, Vancouver Island, (*C. bilituratus* Walker) the var. *bilituratus* is scarcely darker, but the spots on the fore wings are much larger and more distinct, the hind femora are shorter and thicker, with darker patches and spots; the body is shorter and thicker and the wings decidedly shorter, in the ♀ not exceeding the tip of the ovipositor; the ♂ genital armature and abdominal tip are the same in both.

I regard Walker's *bilituratus* as simply a variety of *C. atlanis*, forming one end of a series, of which the Wallula specimens and Redding, Cal. (and Michigan), specimens form another, both resembling, but in a different way, *C. spretus*, the *bilituratus* being most unlike.

I have, since my return, sent specimens of ♂ and ♀ *C. bilituratus* Walk. to R. McLachlan, esq., of London, for comparison with Walker's types in the British Museum. He kindly made the comparison, and writes me: "*C. bilituratus* Walker is, so far as the ♂ is concerned, *decidedly* the same as your larger species. But I am not sure that the presumed ♀ of *bilituratus* is the same." As I took the two sexes in abundance, and no other species of *Caloptenus* was to be seen, I think that all the specimens I obtained were, without doubt, *bilituratus*.

In comparing ♂ *atlanis* from Portland, Oreg., and Massachusetts with a pair (♂ and ♀) from Redding, Cal. (presented by Mr. Scudder), we have in the latter, characters that so closely ally it to *C. spretus* that Mr. Scudder and myself on a hasty examination pronounced it simply a short-winged *spretus*, the form of body and pale coloration and peculiar markings allying it very closely to *C. spretus*. Still it graduated into Shasta Valley forms which I collected, and the anal cerci are narrow, quite unlike those of *C. spretus*, the head is rather large, while the fore wings are differently spotted with dark in the ♀, but in the ♂ the spots are as in the Shasta Valley *atlanis*.

In a male *atlanis* from near San Francisco, received from Mr. H. Edwards, the anal cerci are much as in *C. spretus*, being broad, but otherwise the specimen is very much like those from Shasta Valley.

The Shasta Valley *C. atlanis* ♂ are in most cases rather smaller and decidedly paler than in those from Portland, Oreg., but as large as some of the Massachusetts ones. The anal cerci are narrow. One *C. atlanis* from Shasta Valley, received from Mr. Edwards, had blue hind tibiæ; in all the others they were red.

Specimens from Glenwood, Nev., on the east side of Lake Tahoe, were dark-colored, and spotted much as in those from Portland, Oreg., and Massachusetts, and if mixed up with them could not be easily distinguished. The lateral claspers are narrow; in the Massachusetts specimens they are short and as broad as in the San Francisco ♂. One ♂ from Lake Tahoe had blue hind tibiæ.

In *Caloptenus spretus* from Iowa, Missouri, Colorado, and Salt Lake I find, in my specimens, no essential difference in length of wing; and they can be easily distinguished; not only are the wings much longer and the body larger, but the hind femora are, as a rule, though not invariably, longer than in *C. atlanis*. The anal cerci are in-

* Mr. S. H. Scudder has kindly shown me a specimen of *atlanis* like the Wallula form, from the Yukon River, where it was collected by Mr. Kennicott.

variably short and broad, and, whether *C. atlanis* be only a smaller and short-winged variety or not, it seems to me that the forms commonly known as *C. spretus* and *C. atlanis* should receive distinct names, both common and scientific, for the sake of convenience; and I am, from a study of the material thus far examined, inclined to consider the two forms as specifically distinct. Theoretically I regard *atlanis*, being the more widely diffused form, as probably the parent stock from which *C. spretus* has separated. That *C. atlanis* is a variety of *C. femur-rubrum* is not, I think, warranted by any facts that I have observed, though both forms may have originated from a common ancestor.

Caloptenus femur-rubrum.—This species occurs in abundance at Shasta Valley and Portland, Oreg., *C. atlanis* being associated with it, but much less abundant, as in the Atlantic States. I also received it from near San Francisco through Mr. Henry Edwards, and from Salt Lake, Utah, through Mr. Barfoot. I can, after careful comparison, see no difference in size, length of wings, and the form of the anal cerci between the Pacific coast and Atlantic coast or Utah specimens. In one *C. femur-rubrum*, from Portland, Oreg., there is a deep, well-marked notch in the tip of the male abdomen. In several instances I have seen a faint notch in Massachusetts specimens; on the other hand the male tip in *C. atlanis* is very slightly notched; sometimes it is almost obsolete. The male of *C. femur-rubrum* is not only easily separated from the male *atlanis* by the rounded, entire tip of the abdomen, but also by the very different form of the anal cerci, which are triangular and produced at the end.

As regards the length of wing in *C. atlanis* or in *C. femur-rubrum*, it has for years been known to me that many *C. femur-rubrum* have short wings as well as long wings. I find this to be the case with *atlanis*. In a ♂ *atlanis* from Amherst, Mass., the wings are shorter than in *C. femur-rubrum* from Essex County, Mass. One ♂ *atlanis* from Massachusetts and one ♀ from Illinois had wings of the same length as in *C. femur-rubrum* from Massachusetts. In a ♂ *atlanis* from Shasta Valley and *C. femur-rubrum* the wings are of the same length. The wings in the Lake Tahoe *C. atlanis* are much shorter than in San Francisco or Massachusetts *femur-rubrum*. From these examples, selected at random, I infer that there are short and long winged *C. atlanis* as well as *C. femur-rubrum*.

A singular variety of *C. atlanis* I captured at Amherst, Mass., this year, in October, has curiously forked anal cerci, the males measuring (including the folded wings) 1 nch or 20^{mm}, the wings in one case being slightly shorter than the abdomen.

APPENDIX XI.

DATA FROM BRITISH AMERICA.

[The notes and data collected during a trip made to Manitoba in August and September, 1877, by Mr. Riley, have been embodied in the main report. The Province was remarkably free from the insects, and parties whom we met and who had traveled in early summer from Battleford and from Montana reported the same freedom from the insect throughout the country to the northwest and southwest. The information collected for past years agrees precisely with the report of Prof. G. M. Dawson and with what is given in Chapter II. The prevailing winds, as we learned from Mr. J. Stewart, signal officer at Winnipeg, are from the south in May and June, and from the north and northwest in July, August, and during the autumn. The insects come into the Province either from the south, sometimes as early as the latter part of June, but generally in July, or from the west and southwest later. Those which breed there leave in July, August, and September, almost always towards the south and southeast. They have exceptionally reached as far east as Fort Francis, on Rainy Lake, in Keewatin. We deem the following items of sufficient interest to go on record.]

Although the locust-hatch of 1877 has been almost unprecedented in extent, the exemption of Manitoba and the plains extending westwardly in British America has been established by a general concurrence of testimony. The exodus of last year from the Northwest Territory was so directly south and southeast as to turn the western flank of this province, and we are glad to believe that there has been and will be no return. The plague has passed, and we are informed that Montana and the whole Missouri Valley, at least as far as Bismarck, have enjoyed a similar exemption. The immense masses incubated in Minnesota, after much oscillation, departed southeast; but as yet we have no information where they have gone. The American press is greatly puzzled to solve this mystery which every day increases. The present probability is that the insects, harassed and debilitated by the attacks of ichneumon flies, their natural enemies, have not sufficient vitality for reproduction, and that the innumerable hosts of the sky will scatter and perish, leaving not an egg behind. This natural limitation of the scourge has been greatly aided by the "beastly weather," especially the cold and heavy rains, which have excited so much senseless malediction during the early part of the season. How seldom we penetrate the disguises which mask the blessings of Providence.

The settlements along the North Saskatchewan are exempted by adequate summer rains from the necessity of irrigation—a fact not only suggestive of capacity to sustain a dense agricultural population, but adverse to the generation of the locust. He may migrate thither, although there is no record of his ravages north of Fort Carlton, but the more arid districts southward must be explored for his original breeding-grounds. The conditions of his genesis may exist for a district as large as Belgium, near and north of the international frontier, but tenfold that area will be found in the Mauvaises Terres of Dakota and Nebraska, and the sterile plains of Wyoming and Montana—a region as large as France. It is satisfactory to know that this extensive district was fully depleted of the adult insect by southeast flights in 1876, and we welcome the exemption from return flights in 1877 as a guarantee that a considerable cycle of years will elapse before natural agencies will suffer the great evil to be reproduced.—[*Winnepeg Standard*, September 10, 1877.

Last year but few localities in the Northwest Territories were free from the locust, either hatched or as a foreigner. This applies to the belt of country extending from the Rocky Mountains to the Red River settlements and lying south of the South Branch of Saskatchewan River. West of the Red Deer River (a branch of the South Branch, 109° west longtitude, 51° north latitude) the branch is found on both sides of the river. A small district lying east of the confluence of the South and North Branches and south of the main stream is also free from the visits of locusts. Here farming is extensively and successfully carried on. These facts being pretty constant, it is easy to draw a line on a map of the country showing the northern limits of the locust.

As far as I can make out, only a small brood was hatched in the hills, on the highlands about a mile from the fort. They were not dense. They occupied a piece of ground about one-fourth mile in length and about 150 yards in width. This was on the 1st of August. They soon disappeared.

I was not at this post last year, and can get very little reliable information about the

movements of the locust previous to this summer. In 1875, eggs were extensively deposited throughout the hills, and the following year the hatched broods destroyed everything green.

No cultivation was attempted here last year. This year we have a small vegetable-garden, which is doing well, the number of insects that sojourned not being sufficiently great to do injury. These had their wings loaded with small red mites, a parasite very destructive to the locust. I counted as many as 21 mites on one locust, and seldom less than five. Many also contained one or two maggots (*Sarcophaga carnaria*). They all seemed weak on the wing, and their diseased state was probably the cause of their alighting. Most of those that alighted have gradually disappeared, in what manner I cannot say. I have seen no swarms forming from them and no dead insects can be found on the ground.—[J. G. Kittson, Fort Walsh, Cypress Hills, August, 1877

What is called the Cypress Hills is a very elevated part of the great water-shed separating the Missouri River and its tributaries from the northern rivers. The range extends about 80 miles east and west and is over 40 miles wide. It is divided into valleys by innumerable streams tending south to empty their waters into the Milk River, a tributary of the Missouri. The valleys are deep and their sides steep, often perpendicular; bottoms flat. The sides and small center are generally well-wooded with poplar, larch, and spruce. The highest point of land is 3,800 feet above sea-level. On the south, east, and west the hills terminate somewhat abruptly, but north they gradually lose themselves by undulations into the level country. Fort Walsh is situated 10 miles from the south side and 23 from the west end. I believe farming in the hills would prove a losing speculation; frost comes as early as the beginning of September.

The day before yesterday, when returning from the boundary-line, I came across some grasshoppers in the valley of what is called the Middle Fork of the Milk River, 30 miles south of this post. They were not very numerous; about one to every 309 feet of surface. They were very busy copulating, although it was early in the morning and very cold; about one-half inch of ice covered a small pond near our camp. The bottom of this valley averages 200 yards in width. I had no time to see how far the insects occupied the valley up and down.

The prevailing winds here are the northwest and southwest. To-day we are having a severe snow-storm, and there are already three inches of snow on the ground.—[*Ibid.*, October 2, 1877.

In answer to Circular No. 4, I have the honor to report:

1st. But few insects remained within the immediate vicinity of our post; and half-breed hunters now coming into winter-quarters say that the insects are not to be seen anywhere on the plains. No eggs were deposited.

2d. No new swarms have appeared since my last report.

3d. In the Swan River districts eggs were very thickly laid in 1874 and 1875. The same in the province of Manitoba.—[*Ibid.*, November 14, 1877.

I have known a small white worm destroy great numbers of eggs of late years; also a small red parasitic insect deposits its eggs under the wings of the grasshopper when quite young, which grow with the grasshopper, living on it in fact, and finally killing it. It is only of late years that parasites have made their appearance in sufficient numbers to be noticed, since which time they have destroyed large quantities, but not sufficient to materially diminish the number of grasshoppers. I have not known any powders or liquids to be used. Neither harrowing nor plowing the eggs under has done any good in the province. Have not tried ditching. No machines have been used here, to my knowledge, for killing grasshoppers. Some years ago I saved my garden by dragging ropes over it several times a day.—[H. B. Hall, J. P., Heathingby, Manitoba.

I have no doubt whatever as to the correctness of your statement that the locust breeds permanently in the third prairie steppe. From my knowledge of 'hoppers generally the "bunch grass country" is their permanent home, as the conditions for depositing and hatching their eggs are always there.

The locust has never been able to pass a timber-belt of any considerable width, and the reason seems to lie in the fact that when once they settle in a forest they can never rise out of it, owing to the want of sunshine.

No locusts crossed the North Saskatchewan in 1875, nor can they ever reach the Peace River country, on account of its position and general direction of the wind in the summer months.

Hitherto locusts have been altogether unknown in the Peace River Prairie, and as the whole region is constantly covered with a very luxuriant growth of grass, I am of the opinion that there are no fears of any invasion nor permanent settlement by them in the country. They cannot reach the country on account of the forest, and were it possible for them to do so, scarcely a suitable place could be found for their eggs.

From whatever cause, the *low pressures* pass from Manitoba to the southeast and the

wind-currents of the vast interior plains seem to be propagated on the interior plateaus and pass outwards in the same way. The locusts coming *on* the wind will generally do the same thing, but not always, as a low pressure will cause an inward draught, and if the sun shines the locusts will rise and travel on the wind, which may be blowing from the northeast at the time.—[John Macoum, Belleville, Ont., September 22, 1877.

Lake Winnipeg, Sunday, August 17, 1800.—The beach was covered with grasshoppers, which had been thrown up by the waves and formed one continued line as far as the eye could see. In some places they lay from six to nine inches deep, and now were in a state of putrefaction, which occasioned a horrid stench.

Pembina River, June 25, 1808.—I found great swarms of grasshoppers, which still continue here, and have destroyed the greater part of my vegetables in my kitchen-garden, in particular the onions, cabbage, melons, cucumbers, carrots, parsnips, and beets. They also attacked the potatoes and corn, but those had acquired sufficient strength at the root to resist and sprout up again, whilst plants of a weaker nature had all been destroyed. Those swarms of grasshoppers appear about the 15th of June. They generally come in great clouds from the southward and spread destruction wherever they pass; even the very trees were stripped of their leaves. They pass on northward until millions are drowned in Lake Winnipeg, and cause a most horrid stench, as I have already observed.—[Extract from M S. notes from Henry's Journey from Lake Superior to the Pacific Ocean, 1799–1816.

[From the Hon. Donald Gunn, one of the oldest settlers in Manitoba, and an enthusiastic observer of nature, we obtained the following reports, the second one called forth by the fact that several other old residents questioned whether the insects ever came into the Province as early as June. The above-quoted notes from Henry's journey and other data that we have elsewhere referred to corroborate the accuracy of Mr. Gunn's records:]

These destructive creatures made their first appearance in the colony in the latter end of July, in the year 1818, six years after the commencement of the settlement. The crops were ripe when they came, and they did not injure the wheat to any serious degree, but it was otherwise with the barley, which they attacked by cutting off the ears; but, with all their voracity, they could not eat the ears, and the settlers secured as much as they were able to gather by gleaning. This great swarm, after accomplishing the work of reproduction, disappeared. * * * *

After this digression we will turn our attention to what took place in the spring of 1819. After the genial rays of the sun had communicated to the earth the warmth necessary to hatch the ova deposited during the preceding season, the young grasshoppers made their appearance in immense numbers. During the first eight or ten days of their existence they are feeble, inactive, and innoxious, but as they become strong enough to travel, they seemed to have moved in one direction, devouring every green thing that they found in their way, leaving in the evening bare and black what they found in the morning green and flourishing. And thus they destroyed the unfortunate settler's expectations of realizing what otherwise would have been the reward of his industry.

If the myriads which ravaged the land in 1819 took their flight before they deposited their ova, others in numbers equally great came to occupy their place, whose progeny destroyed the husbandman's hopes for 1820; and, owing to a similar cause, his fortune was no better in 1821. Thus, for three successive seasons, were the fruits of the earth destroyed by these pests.

Six and thirty years passed before these creatures made their appearance again within the limits of the settlement. But in the summer of 1857 a swarm fell on the Assiniboine. They deposited their eggs, and in the following spring and summer they destroyed all the crops within their reach; but be it observed that their progress is slow until they cast their slough; their wings expand and dry, when in a few days they fly away.

In the latter end of June, 1864, grasshoppers appeared in considerable swarms, extending over the whole of the settlement. They did very little injury to the wheat-crop, but were the cause of great loss in the barley by cutting off the ears, which people could find neither time nor hands to gather. About the beginning of July they began to deposit their ova, and continued doing so until the beginning of October. In the following summer of 1865 the young brood destroyed some fields and injured many more, but they left many fields that they did not touch. After they got their wings they left this part of the country. On the 9th of June, this year, a sprinkling of grasshoppers fell, extending from Fort Alexander, on the river Winnipeg, to Manitoba Lake, and likely over the Swan River region, but they were not numerous near the Red River, and although they deposited their ova, the young ones proceeding from them were too few to do any perceptible damage; but in the month of August, 1867, they made their appearance in such great numbers that they literally covered the whole face of the country. The wheat was ripe and beyond their power to injure, but many had great difficulty in preserving even part of their barley. I need not say that

the ova deposited in the fall months produced immense swarms of these nauseous and noxious vermin, which destroyed everything that had been sown throughout the length and breadth of the land the next spring. The potatoes had their stalks eaten into the ground, but, after the grasshoppers had left, so far recovered as to produce a small quantity of very small potatoes.

In the month of August, 1869, great swarms of grasshoppers fell on each side of the Red River from Pembina to a distance of ten miles below Upper Fort Garry and for some miles up along the Assiniboine River. These, following their instincts, deposited their ova and disappeared. In the spring of 1870, many of the farmers in the districts where the young grasshoppers began to appear did not sow, but those who did sow had the mortification to see their fine and fertile fields desolated. Some potatoes were raised in these districts, but the perfection to which they attained was greatly owing to the lateness of the fall.

And here permit us to remark that, from what we have been able to observe, we are inclined to think that grasshoppers never deposit their ova in the soil in which they themselves came into existence.—(Published by order of the legislature in 1871.)

CHARLES V. RILEY:

DEAR SIR: I received your note of the 3d instant, which came to hand on the 15th. I notice what you say in regard to my three skeptical friends, Hay, Kennedy, and his grace of St. Boniface. But, fortunately, I have not trusted to that but too often treacherous faculty, memory, but kept a journal of occurrences, though a very brief one, and in my notes of 1864 I find it thus written:—"June 28th. The grasshoppers fell in great numbers from Upper Fort Garry to Laire's post, on the Assiniboine, a distance of twenty-five miles, committing great ravages on the crops. July 7th. Clear warm day, wind blowing freshly from the southwest, about 10 a. m. Swarms of grasshoppers flew over this place (Little Britain) during the space of three hours, in a north easterly direction the lowest a few yards from the ground the highest at a very great height; those near the ground falling down in great numbers, so much so, that a dozen might be seen on a square foot. July 8, 10 a. m. Swarms passing to the east at a great height, very few coming to the ground. 9th. Having rained during the day, grasshoppers benumbed. 10th. Grasshoppers flying to the east, numbers falling to the ground. 11th. Clear and hot, wind south. Grasshoppers pairing and depositing their eggs. 24th. The last week very warm. The grasshoppers are laying their eggs in great numbers; some of their nests contain from 26 to 31 eggs. They have cut off the leaves of the wheat, but the grain is still growing. They extend 5 or 6 miles to the west of the river. They destroyed the barley crops, cutting off heads. The potatoes did not suffer much."

So much for '64. In '65 I went to hunt at Shoal Lake, accompanied by my son and an Indian. We left my place, Little Britain, on the 5th of June. On the evening of the 6th, we arrived on what was to be our hunting-grounds. Our object was to collect birds with their nests, with every other creature that we could find, all of which we sent in due time to the Smithsonian Institution, and, as our work demanded, kept a sharp look. On the 7th, we moved to a point near to where we expected to find fowls in great abundance. 8th and 9th, my men were off hunting and returned late on the 10th; they landed on the extremity of the point, and came to me in the night. Next day, which I think was Sunday, was very clear and warm. We went to see the hunt, and on the point found full-grown grasshoppers along the shore, having been drowned in the lake. The wind began to blow from northwest and the grasshoppers began to fly before it. "From their red legs, they appeared to be of the same species as those of last fall, but there were no young ones within twenty miles of the place. June 12th, grasshoppers flying to the northwest in great numbers. Wind at the south. Skinning and cleaning eggs all day. Tuesday, left the east side of Shoal Lake for the Manitoba Lake. We arrived at St. Laurent late in the evening; learned that the Franklin gulls had abandoned their former breeding-places at the south end of Lake Manitoba, and were only to be found north of the Oak Point, for which place we set out; traveled till dark, slept on the open plain. Left camp early; were delayed at Oak Point for some hours by heavy showers of rain; learned from the residents that the grasshoppers came with a southwest wind that blew on the 9th. Passed on to Little Swan Creek; encamped. Went to hunt in the marsh for gulls and eggs; secured some gulls, but found no nests. Thursday, clear fine day, sent the Indian and William to hunt. They returned in the afternoon with bushels of eggs and a number of the parent birds (Franklin gulls). Helped skinning and cleaning eggs all day. Friday, raining and blowing freely from the south. Left camp about 9 a. m.; traveled on the east of Manitoba Lake. Full-grown grasshoppers numerous in some places along the road. Saturday, made an early start and arrived at Poplar Point at 4 p. m.; very few locusts seen to-day. Returned home on the 22d, where I found a few grasshoppers in the neighborhood of my place, and learned that they made their appearance there on the 8th or 9th. Afterwards found that a few visited Fort Alexander about the same time."

Here I have given you verbatim what I recorded twelve years ago for my own satis-

faction and instruction, never dreaming for one moment that I would have to refer to it in justification of my veracity on the locust question; and here I must acknowledge my obligations to the mice for sparing my record, it having been thrown, after the specimens had been packed, into an old box or trunk in the garret, among some other loose papers to which these little customers showed no sparing mercy. I have found a sheet of the list of specimens forwarded to Washington in 1865, but I do not see any locust on it. If my memory serves me right, we forgot the vial in which they were at the place where we had breakfast the day we arrived at Poplar Point. If that has been the case, I may not have written about them in my report on the egging expedition, which has been published in full in the report of that year. I am not acquainted with the army-worm, but of moths we have a great variety, and each of these varieties in great numbers, during the summer months. You will observe that in this rambling communication I have quoted my diary of occurrences as they were entered in my note-book. My son, who had been with me on the trip to the lakes, remembers the appearance of the locusts near the lakes and of seeing them along the Red River after we returned home, June 22. Other parties in this vicinity remember having seen them that year in June, but not in great numbers.— Hon. Donald Gunn, September 16, 1877.

APPENDIX XII.

RECORD OF AUTUMN FLIGHTS EAST OF THE ROCKY MOUNTAINS IN 1877.

[The following replies are to a circular sent out by Mr. Riley, inquiring especially as to the movements of winged locusts in the autumn of 1877, after the northward flight had ceased, the inquiry being as to whether such autumn swarms were noticed. These replies show that there was a considerable movement of scattering swarms; that the direction was essentially south, and that no serious damage was done. Eggs were laid in but a few exceptional instances, and no young locusts will hatch in the spring of 1878, except in a few small and restricted areas widely separated. The names of the correspondents may be learned by referring to the list in Appendix 26.]

MINNESOTA.

Jamesville, Waseco County.—"Some few settled here about the time of the departure of those first hatched, but all left again immediately. None since."

Luverne, Rock County.—"Swarms passed over from north-northwest and northeast on following dates: June 27; July 5, 8, 9, 10, 15, 20, 28, 31; August 1, 2, 7, 8, 9, 11, 12, 13; some alighting in small squads, but doing no damage."

IOWA.

Athol, Sioux County.—"After the departure of the young locusts, swarms from the north-northeast and northwest passed over: July 15, 16, 20, 27, 28, and 31; August 1, 6, 7, 8, 9, 21, and 22. During the flights more or less of them alighted."

Algona, Kossuth County.—"The wind was from the north when the Minnesota crop passed over."

Ames, Story County.—"A few swarms, or straggling parts of swarms, were noticed high in the air, going south. No *dense* swarms were seen."

Carroll, Carroll County.—"Several swarms from the northwest passed over us, and small portions of them alighted. They lay all over in pairs, but took wing with the first favorable wind, leaving no eggs."

Chickasaw, Chickasaw County.—"No."

Council Bluffs, Pottawattamie County.—"Fresh swarms passed over from the north. Some settled for a nightly visit; in some cases remained a day or two waiting for a wind to waft them southward; did no damage; laid no eggs."

Denison, Crawford County.—Large swarms passed over in August from the northwest. A few alighted, but went off again."

Denmark, Lee County.—"Never been here to my knowledge."

Des Moines, Polk County.—"Fresh swarms came in from north and northwest in August, but did little damage."

Lemars, Plymouth County.—"About one-third as many as we had the previous year came down and settled for a time. They came from the northwest, and a portion of them remained about two weeks, doing a little damage to gardens and small grain."

Little Sioux, Harrison County.—"Yes; a few swarms of limited numbers."

Malvern, Mills County.—"A few swarms, not large, passed over here from the northwest about the middle of September. None settled."

Sac City, Sac County.—"Locusts passed over this locality in great numbers during August, going south-southeast and southwest, but none alighting."

Shelby, Shelby County.—"Yes, on the 17th August, from the north; staid three days."

Sidney, Fremont County.—"Frequent swarms were noticed on the wing, but their stay with us was of short duration. None passed over or settled."

Sheldon, O'Brien County.—"Yes; broken swarms were flying during most of the season."

Sioux City, Woodbury County.—"None settled in this county to speak of, but a great many passed over to the south."

Spirit Lake, Dickinson County.—"Fresh swarms did pass over here from the northward; but whether from north, northeast, or northwest, I cannot say."

Webster City, Keokuk County.—"Myriads of grasshoppers passed over, apparently going southward, as soon as they had acquired the power of flight. A few alighted, but not enough to do appreciable damage."

West Liberty, Muscatine County.—"No."

Alta, Buena Vista County.—"They continued to pass back and forth for about three

weeks after the first flight of young from this section, but were supposed to be driven back and forth by adverse winds."

Sioux County.—"Yes; broken swarms were on the move."

Tabor, Fremont County.—Answer to 2d interrogatory: "I find in my weather record, June 22, locusts flying north. This was the first of their leaving. July 10 I find the same record repeated. This was about the time most of our crop of locusts left us. August 7, locusts flying northwest; but few have lighted. These were from some other section. These left in a day or two and were the last we have seen here."

NEBRASKA.

Pleasant Hill, Saline County.—"Large swarms passed over from the northeast, undoubtedly from Northwest Iowa, South Minnesota, and Southeast Dakota. Settled in places here; avoided corn-fields; settled on small grain and grass; appeared to be in a feeble, degenerate condition; always left next morning; ate nothing; appeared to come down simply to rest; departed in a southwesterly direction."

Steele City, Jefferson County.—"From the 13th to the 23d of September a good many passed over, mostly from the northeast."

Genoa, Platte County.—"From August 6 they commenced going south and southwest in swarms, which continued daily, whenever the wind was favorable, for over a month. They showed no disposition to alight, except when compelled to do so by opposing winds."

Hendricks, Otoe County.—"Not any."

Lincoln, Dodge County.—"None visited, and none came from north or northeast or west. A few passed over, going north."

Great Bend.—"Some from the northwest passed over."

Salem, Richardson County.—"Yes. Fresh swarms were seen to pass over this point on the 8th and 9th of August. Locusts were flying over here on the 9th very thickly, and on the 9th a few settled, but departed in a day or two. Then on as late as the 25th of August stragglers could be seen at intervals of a few days passing over, and invariably coming from the north and northeast and going toward the south and southwest, traveling only with a gentle wind blowing from the north or northeast."

Amazon, Franklin County.—"I believe not."

Brownville, Nemaha County.—"No fresh swarms from north or northwest passed over or settled in this locality after those hatched last spring had departed."

De Witt, Saline County.—"Fresh swarms from the northeast passed over, and some few settled, but went off again in a few days, except a few stragglers that remained until October 1. No eggs were laid by these."

Johnson, Nemaha County.—"But few."

Nebo, Platte County.—"After our own crop left, swarms were flying over us for many days from the northeast. None stopped."

Lincoln, Dodge County.—"No."

Omaha, Douglas County.—"There were swarms in the air, but from whence or whither bound I do not know. None settled. The migrating swarms were all moving in a northerly direction, mostly west of north."

Patron, Butler County.—"Some came from northeast, going south or southwest. They lit down for three days."

Plattsmouth, Cass County.—"No."

MISSOURI.

Carthage, Jasper County.—"No."

Defiance, Worth County.—"They did not."

Forest City, Holt County.—"I noticed some flying in the air. They seemed to be going in a westerly direction."

Flag Springs, Andrew County.—"A few passed over from the northeast about the 20th of August last, but very few settled with us."

Greenfield, Dade County.—"No."

Lamar, Barton County.—"On several days in August swarms were seen passing southward. None settled down here. A very few came from the northeast and lit down during the last of October."

Little Osage, Vernon County.—"After those which hatched in spring had left, none were seen to pass over or settle in the neighborhood."

Morrisville, Polk County.—"No. No swarms came or passed over that I heard of."

Mount Vernon, Bates County,—"No."

Oregon, Holt County.—"Some swarms did pass, but the wind was from the south. Passed over and a few lit down before a storm one day along the railroad. No more."

Oregon, Holt County.—"August 14, large numbers passed over, flying southwest. A few came down, and from that time till the present they have remained."

Pickering, Nodaway County.—"About the 20th of September, during several days, large swarms were observed to pass over our county from the northwest to the southeast, but I cannot learn an instance of their settling down."

Rochester, Andrew County.—"No."

Reed's, Jasper County.—"Some passed over, going northwest."
Rockport, Atchison County.—"Large swarms from the north passed over in August and September, and a few dropped down, but did not deposit any eggs."
Sarcoxie, Jasper County.—"Swarms passed over from the east and northeast about the time they left here, but none settled." "No."
Carthage Jasper County.—"None passed over."
Doylesport.—"No fresh swarms appeared this season."
Golden, Barry County.—"A few passed over for two days from northwest."
Mount Vernon, Lawrence County.—"No; they did not."
Rockport, Atchison County.—"Yes; but very few."
Seneca, Newton County.—"A very few passed over from the northwest. Once in a great while one stopped; would not have been noticed only by close observation."
Stockton.—"Not that I have heard of."

ARKANSAS.

Bentonville, Benton County.—"A few passed over the last days of September. A very few alighted in some localities. Fresh swarms passed over from northwest, but none settled."
Carrollton, Carroll County.—"No swarms have been noticed to pass over since last fall."

KANSAS.

Abilene, Dickinson County.—"There were locusts passing over in the early fall from northeast; none settled."
Alma, Wabaunsee County.—"Some were observed high in the air for several days in September, passing from northeast to southwest."
Belle Plaine, Sumner County.—"On the 9th and 10th of September they passed over in considerable numbers from northeast; settled down in small numbers. Did no damage."
Buffalo, Wilson County.—"There were rumors that some locusts had passed, but I doubt it. I have seen none but the few that summered here, and they have laid no eggs that I am aware of."
Bunker Hill, Russell County.—"About 26th to 30th August some passed over from nearly north to a little west of south. For two or three days a very few settled down toward evening, disappearing next day."
Burlington, Coffee County.—"A few locusts passed over from the north. Did not observe any eggs laid."
Burr Oak, Jewell County.—"The grasshoppers were seen flying over to the west of north in the month of May. In the latter part of August grasshoppers flew from the north to the south. A few came down, but did very little damage. The number was not very great, not as many as passed over last year. The wind was in the north. Some few locusts came down, enough to show that we were not deceived as to what they were."
Centralia, Nemaha County.—"South-southwest; wind generally westerly or northwesterly. Some flights very dense. Enough came down to satisfy me that they were locusts"
Chanute, Neosho County.—"Yes; two small flights were observed to pass on the 9th and 17th of September; a few of them alighted and are here yet, but have done no harm nor laid any eggs. Wind, on the 9th, was from northwest, and on the 17th from northeast. Had rained the preceding nights."
Clay Centre, Clay County.—"They flew from north to south till the 6th of October."
Concordia, Cloud County.—"Considerable numbers passed over this county from north-northeast or northwest, as the wind happened to be. Settled in 'spots.' Took occasional fields of corn. Went south or southeast. No eggs. A good many have lit in this vicinity recently, and some little damage has been done by them in places, though not enough to make a fuss about. They have not staid long in any place; only a few days at the longest; and they do not seem hungry at all. Millions of the little pests have been flying over this place for several days past."
Cope, Jackson County.—"Some seen on several days from the north; direction southwest; very high."
Elk City, Chautauqua County.—"I did not see any locusts on the wing in any direction. Others say they did. Others, again, say that it was large ants, or willow or thistle down."
Ellsworth, Ellsworth County.—"Winged locusts passed over in the fall from north to south. Flight not very dense."
Emporia, Lyon County.—"None passed over."
Fenwick, Republic County.—"From 9th to last of August they were going south in all favorable winds; most of them very high in air."
Junction City, Davis County.—"Many were seen flying north, south, and east with the wind; a few dropped, but left without doing harm."

Great Bend, Barton County.—"'Hoppers flew over at different times during August; course from northeast to southwest; flight high, and at times very dense."

Harveyville, Wabaunsee County.—"They passed over in great numbers from the north and northwest, but very few came down."

Hiawatha, Brown County.—"Some passed over from the 10th to 20th of August from northeast to southwest; did not settle."

Humboldt, Allen County.—"A few scattering ones settled here this fall; they were flying south from north."

Hutchinson, Reno County.—"A few passed over in the fall; general direction taken southeast."

Indianola, Butler County.—"They flew thickly in September with northwest wind."

Industry, Dickinson County.—"Several droves passed over in a southerly and southwesterly direction, chiefly during the month of August; wind was blowing from the north; none were noticed to settle. We have had some half-grown ones about here until lately."

Jewell City, Jewell County.—"All that passed over were from southeast going northwest and north."

La Cygne, Linn County.—"None seen."

Le Roy, Coffey County.—"None noticed."

Lazette, Cowley County.—"A few passed over, none alighting."

Lyons, Rice County.—"Some passed over in September, flying in a northwest direction. Light wind from southeast."

Medina, Jefferson County.—"Saw none flying this fall."

Minneapolis, Ottawa County.—"Some passed over going southwest. Wind northeast. None settled."

Newton, Harvey County.—"For several days in August they were observed passing over, course to southwest."

Olathe, Johnson County.—"None were seen flying over."

Olivet, Osage County.—"About the 1st of September two small squads were observed to pass over, going south, but few settled; did no harm and deposited no eggs."

Osage Mission, Neosho County.—"Locusts flew over September 10 to 13; some came down, but generally left again; they came from northwest; seemed to fly with the wind."

Osborne City, Osborne County.—"No locusts were observed to pass over us from the north, northwest, and northeast in the fall; I observed some passing from the south in June and July, traveling north, but they did not stop with us; they have not returned from the north."

Oswego, Labette County.—"No locusts passed."

Russell, Russell County.—"A few settled from northeast one day during last of July, but went on next; a few dropped from time to time during the flight."

Salina, Saline County.—"Yes, they were seen nearly every day at the end of August and beginning of September, going first south and then northwest; a swarm passed in late August or early September, going south. Afterward they came back, flying west by north; none came down."

Spring Hill, Johnson County.—"A *few* settled down here at different times in August and September, but did no damage and were thought to be from swarms passing over from the south; they are here yet, but have deposited no eggs."

Tabor, Clay County.—"Several small swarms passed over from the north, but upon the next change of wind they passed back north again; they had probably hatched in section north of us."

Valley Falls, Jefferson County.—"Winged locusts passed over Valley Falls during August for several days, generally from northwest; did not settle or do any harm; the general direction was southeast, one day in considerable numbers; an occasional crippled or sick one would light. No damage done. Wind south or southeast."

Wichita, Sedgwick County.—"A few passed over from the northwest till the wind changed from north to south; a portion settled and destroyed some wheat; laid no eggs. The northwest wind which prevailed last Sunday swept high overhead, scattering flights of grasshoppers. The insects flew very high, but in such inconsiderable numbers that, had they come down, no damage would have resulted."

Wilmington, Wabaunsee County.—"Saw none pass over."

Winfield, Cowley County.—"Not that I am aware of."

Yates Center, Woodson County.—"They were seen by some, passing from northwest to southeast during prevalence of north wind; but for the truth of this statement I am not willing to vouch, as I did not see them; however, there could not very well be any mistake in regard to them passing with the wind. They did not settle."

Oskaloosa, Jefferson County.—"Have seen none flying this fall."

Paola, Miami County.—None were noticed passing over this locality. Don't think there were any 'hoppers in this county this year."

Peabody, Marion County.—"They flew over quite a number of days during the fall, from northeast and northwest, often from east to southeast; none settled; flew most densely on October 21, from northwest to southeast."

Riley, Riley County.—"Some passed over to the south; none settling down."
Rush Centre, Rush County.—"Yes; from the north; none settled."
Salina, Saline County.—"A few passed over, going south, about the 1st October; did not settle in this vicinity."
Seneca, Nemaha County.—"Yes. They did not settle in very large numbers and did no harm; they seemed to be undecided about the direction, but generally went in a southeast course. These flights, on favorable days, were quite dense. There was no mistake about these being the genuine article."
Smith Centre, Smith County.—"Some passed over during September and latter part of August, northwest."
Stockton, Rooks County.—"Some flew over in July; none settled."
Lyndon, Osage County.—"Yes, but not in great numbers. A few straggling ones settled, but did no harm and disappeared again; the direction was from the north or northeast to the south or southwest. They were few and scattering compared with other flights."
Toledo, Chase County.—"None."
Fredonia, Wilson County.—"A few passed over from the northwest; did not settle; southeasterly direction; wind northwest."
Uniontown, Bourbon County.—"I saw no locusts flying in any direction this fall. Some persons assert that they were seen flying south in September."
Atchison, Atchison County.—"Some grasshoppers passed over, I am told, on their way southward, but none alighted. Some passed over late in summer; could not tell in what direction; only knew it from a few scattering ones alighting."
Belleville, Republic County.—"Yes; very few settled."
Chanute, Neosho County.—"Yes; a few were observed flying upon a northerly wind on the 7th and 9th of September. A very few alighted and are here yet."
Claytonville, Brown County.—"Large swarms passed over from the north and northeast, but few fell down, and none remained."
Elivon, McPherson County.—"A few passed over."
Farland, McPherson County.—"They were seen for two days, about the middle of September, journeying southward."
Galesburg, Neosho County.—"No swarms passed over or settled in this neighborhood after those hatched here had departed."
Great Bend, Barton County.—"From the middle of August to the middle of October occasional swarms passed over this section, mostly from the north, but sometimes from the northwest or northeast."
Hiawatha, Brown County.—"No swarms passed or settled here."
Iola, Allen County.—"No locusts passed over or settled in this locality during the present season."
Irving, Marshall County.—"No fresh swarms have settled here from any quarter, but many have passed over from the south and east."
Junction City, Davis County.—"Did not identify any genuine swarms. Cottonwood-seed and milkweed-down were flying, and were supposed by some to be grasshoppers. On the 20th and 21st of August there were large swarms flying over the eastern part of this county, going south. They were nearer to the ground than any I have seen this year. Swarms passed over, but none settled."
Lane, Franklin County.—"A few swarms were seen flying over, going north or northwest. Only in a few cases did they visit us. They disappeared the following day, doing no perceptible damage."
Lawrence, Douglas County.—"I saw no swarms pass over, only those that came from the southeast, probably from Olathe or Fort Scott."
Leavenworth, Leavenworth County.—"No locusts in this county this year."
Logan, Phillips County.—"A few passed over from the north, but very few settled in this neighborhood, and those did not stay over twenty-four hours and did no damage."
Manhattan, Riley County.—"Great numbers went over from the north, from the middle to the last of August. Some settled, but remained a very short time."
Millwood, Leavenworth County.—"A few came in this fall; are now here."
Neosho Falls, Woodson County.—"No; but they passed over north from Texas."
Newton, Harvey County.—"About the middle of September there were some flying from the north and northwest to the south and southeast, but none lighted."
Norton, Norton County.—"Swarms passed over occasionally from the 16th of July until the middle of September, but they were very light."
Oakwood, Linn County.—"No."
Olathe, Johnson County.—"No."
Oswego, Labette County.—"No; none from any direction."
Ottawa, Franklin County.—"No. A few passed over at various times."
Parsons, Labette County.—"None that I saw or heard of. No."

COLORADO.

Colorado Springs, El Paso County.—"No locusts arrived in this region during the summer, nor do I hear of any fresh swarms having arrived in any portion of the State."

Denver, Arapahoe County.—"No. There were no fresh swarms from north, northeast, or northwest. In the latter part of July they passed over here for two days, flying northeast."

Georgetown, Clear Creek County.—"No swarms from the north, northeast, or northwest passed over this district."

La Porte, Larimer County.—"Swarms from the northwest to southeast in August, but think they came only a short distance."

Larkspur, Douglas County.—"Yes, but not in any quantity."

Pueblo, Pueblo County.—"A few swarms were observed in the early part of July, passing over from the north or northwest. None of them came down."

Wheatland, Larimer County.—"None."

Greeley.—"I have seen none."

Howardsville.—"No migratory swarms have appeared, to my knowledge, in this locality."

Pleasant Valley.—"None were noticed to pass over."

Pueblo, Pueblo County.—"A few swarms were observed in the early part of July passing from north to northwest. None came down."

Saguache.—"None."

TEXAS.

Austin, Travis County.—"None over this section. No fresh swarms from the north after their departure north and northwest."

Bastrop, Bastrop County.—"Swarms of unknown insects, in their flight resembling locusts, were seen high overhead in October, and occasional locusts alighted in counties to the northwest last month, but are doing no harm."

Black Jack Springs, Fayette County.—"I understand they have made their appearance in some counties."

Calvert, Robertson County.—"There were no swarms from any direction passing over or settling herafter ours had left."

Dallas, Dallas County.—"None. No."

Denison City, Grayson County.—"No; there have been no fresh swarms."

Headsville, Robinson County.—"About the last of August immense numbers passed over our country, but high up in air. A very few came down, from exhaustion perhaps."

Helotes, Bexar County.—"On September 28, 29, and 30, swarms passed over this country, but so far as I can understand none have laid, or even alighted on the ground."

Houston, Harris County.—None.

APPENDIX XIII.

RECORD OF LOCUST FLIGHTS EAST OF THE ROCKY MOUNTAINS IN 1877.

[The following data form a calendrical register of locust flights during the year, and, together with those in the preceding appendix, make a full record of locust movements. Wherever the name of the correspondent is not given it may generally be ascertained by referring to Appendix 26.]

April 16.

Austin, Travis County, Texas.—The first flight of grasshoppers, I think, was on the 16th of April.—[Jno. H. Secrist.

April 21.

Austin, Travis County, Texas.—The first general flight was on the 21st of April; course, northwest.—[Jno. H. Secrist.

April 19 *to* 24.

Bastrop, Bastrop County, Texas.—Flying north.—[James Moore.

April 24.

Calvert, Robertson County, Texas.—Have been migrating from south of this for ten days, and those which have attained wings here occasionally join them.—[W. L. Coleman.

April 26.

Calvert, Robertson County, Texas.—Have been migrating south of this for ten days, and the winged ones here occasionally join them.—[D. Parker.

May 1.

Travis, Travis County, Texas.—There was a flight of locusts here to-day.—[Jno. H. Secrist.

Chickasaw, Chickasaw County, Iowa.—From 3 p. m. until sundown their direction of travel is always with the wind, but they travel more by northwest winds than by any other; consequently they have operated farther east each succeeding year.—[O. H. Hobbs.

Calvert, Robertson County, Texas.—They commenced flying in great numbers from this place at about 12 o'clock. The thermometer was 44° at 6 a. m. and 72° at 12 m. in the shade, and 95° in the sun.—[W. S. Coleman.

Headsville, Robinson County, Texas.—Numerous 'hoppers did "come down" to earth and stay all night—the night of May 1. On that day they made a fine drive by the million for your country.—[W. D. Donaldson.

May 8.

Bastrop, Bastrop County, Texas.—They left northward.—[James Moore.

Salado, Bell County, Texas.—They arrived at 11 o'clock and 30 minutes a. m. The wind was blowing strongly from the south during the entire day. The weather was mild, nights pretty cool, days warmer, and, until near 4 o'clock p. m., fair, when it clouded up and remained so. Direction of the flight, north; swarm very dense; they appeared in a higher strata of air than when going south last fall.—[J. H. Myers.

May 12.

Ellis, Ellis County, Kansas.—No grasshoppers in this county.—[H. L. Brounson.

May 15.

Amazon, Franklin County, Nebraska.—'Hoppers at noon flying north on a south wind; very thin, not more than one to a square rod.

May 16.

Chapman, Merrick County, Nebraska.—Flying to northwest at 3 p. m., wind southeast; 5 to 100 feet high; weather clear; thermometer 65°.

May 17.

Trego County, Kansas.—Flying west of north on a south-southeast wind.

Glencoe, Dodge County, Nebraska.—Flight from southwest.

May 18.

Junction City, Davis County, Kansas.—Not any locusts on the wing have yet been seen here. Wind southwesterly for three days past.—[H. H. Mead.

Kearney, Kearney County, Nebraska.—Large swarms flying north; a few stragglers alighting.

May 19.

Nebo, Platte County, Nebraska.—On the 19th of May I noticed one now and then come down, but could see none in the air. The day was clear and warm, with southwest wind; moderate breeze.—[John Wise.

Patron, Butler County, Nebraska.—Going south; weather warm; thermometer 75°.

May 21.

Ellis, Ellis County, Kansas.—Going northwest; very high.

Lincoln, Nemaha County, Nebraska.—A swarm of locusts lit down at Grand Island on the Union Pacific Railroad on Monday evening, May 21; they came with the south wind and next day went a little east of north.—[Samuel Aughey.

May 22.

Oswego, Labette County, Kansas.—They were flying over this place, from the southwest.—[C. C. Perkins.

May 23.

Norton, Norton County, Kansas.—They appeared on the 23d of May, going northwest.—[Thos. Beaumont.

Logan, Phillips County, Kansas.—Wind from south; locusts flying north at 10 a. m.

May 26.

Kit Carson, Bent County, Colorado.—A few 'hoppers dropped on ground in the evening of May 26. There was a heavy storm passing over at the time, and so near night we could not tell whether the air was full of them or not; wind blowing from north.—[W. A. Morrison.

Logan, Phillips County, Kansas.—Flying north at 10 o'clock a. m., on a south wind.

Ogalalla, Keith County, Nebraska.—Flying north from 9 a. m. to 3 p. m.; wind light.

May 27.

Kit Carson, Bent County, Colorado.—The air is full of 'hoppers this morning, flying very high; very few are alighting; wind blowing northeast, not over two miles per hour.—[W. A. Morrison.

Ogalalla, Keith County, Nebraska.—Large numbers of locusts were noticed flying northward from early in the forenoon till late in the afternoon; light north wind; moderately warm; partly cloudy; did not appear very dense, but were very high.—[W. P. P. St. Clair.

Twin Falls, Greenwood County, Kansas.—Flying west of north; wind south of east.

Ogalalla, Keith County, Nebraska.—Flying very high, northward, from 9 a. m. to 3 p. m.; weather warm and clear.

North Platte, Lincoln County, Nebraska.—Immense swarms flying north 30° west; very high; few alighting.

Monotony, Kansas.—Commenced passing over at 10.45 a. m.; north, 4 miles; increased to 10 miles per hour; clear and warm; last swarm passed at 3.30 p. m.—[B. Callahan.

May 28.

Ogalalla, Keith County, Nebraska.—Large numbers of locusts passed over from early forenoon till late in the afternoon; wind north, light; moderately warm; partly cloudy.—[W. P. P. St. Clair.

Twin Falls, Greenwood County, Kansas.—The air was full of them from the south, going north or little west of north, as the wind carried them that way; none dropped here.—[Milton M. Wheeler.

May 30.

Camp Robinson, Nebraska.—A light and scattering flight of locusts came here to-day from the east, probably from Kansas.—[W. L. Carpenter.

Logan, Phillips County, Kansas.—Locusts passed over this place, and made their appearance at about 10 a. m.; wind south, quite sharp; locusts flying north.—[J. W. Benjamin.

Raymond, Rice County, Kansas.—This afternoon, at about 3.40 o'clock, a few locusts came down with a light shower, about 100 to an acre; could see none in the air. Wind strong from southwest. Warm and cloudy.—[C. D. Stevens.

May 31.

Deerfield, Steele County, Minnesota.—Swarms flying.

June 1.

North Platte, Lincoln County, Nebraska.—North 30° west; immense swarms flying; few alighting.

June 3.

Barton, Labette County, Kansas.—They commenced flying over northward in the latter part of May in small numbers; very few have come to the ground.—[J. Lindas.

Norton, Norton County, Kansas.—Going northwest, wind south.

June 5.

Raymond, Stearns County, Minnesota.—Flying southeast from 10 a. m. to 12 m. Wind nor hwest.

South Bend, Blue Earth County, Minnesota.—Flying from 8 a. m. to 6 p. m.

June 9.

Medary, Brookings County, Dakota.—Wind northwest, strong. Flying very high, southeast.

West Newton, Nicollet County, Minnesota.—Locusts flying.

Saint Paul, Ramsey County, Minnesota.—Flying northeast; wind from northwest; some alighting.

Watale, Benton County, Minnesota.—Flying southeast; wind northwest; weather clear.

June 10.

Audubon, Becker County.—Alighted from south; remained till July 1; very limited in numbers.

Morristown, Rice County, Minnesota.—Appeared at four o'clock.

Claytonville, Brown County, Minnesota.—Hoppers flying.

Smithfield, Cache County, Utah.—They first began to migrate, but the distance was small and the numbers limited.—[James S. Cantwell.

June 11.

Pueblo, Pueblo County, Colorado.—Reports come in that large flights of locusts have been noticed steadily winging their way northward.—[Saxon.

June 12.

Salina, Saline County, Kansas.—Flying very high to northwest; wind southeast, moderate.

June 11–13.

Denver, Arapahoe County, Colorado.—There have been clouds of grasshoppers in the air for the last three days; they moved west on the 11th; on the 12th and 13th they moved north; wind south.—[Denver News.

June 12.

Bosland, Kansas.—Locusts passed over with a moderate southeast wind at about 11 o'clock a. m., and passed by in about two hours, in a northwest direction. Weather clear, with about 90° F.—[J. T. McKitrick.

June 13.

Lindsborg, McPherson County, Kansas.—The first flying swarms of the season in this locality passed over here June 13. The wind was blowing from the east, hence their flight was westward. The day was cool and cloudy.—[Dr. J. B. Curtiss.

Agenda, Republic County, Kansas.—Locusts flying southwest; weather cool.

Tabor, Clay County, Kansas.—Locusts flying west.

Claytonville, Brown County, Kansas.—Locusts flying; wind south-southwest; thermometer 75°.

Alma, Wabaunsee County, Kansas.—Locusts flying at 2 p. m. in northeasterly direction; wind from southwest, 30 miles per hour; 800 to 1,000 feet high.

June 14.

Agenda, Republic County, Kansas.—Flying to the northwest; weather warm.—[Stephen Bradley.

Pawnee, Pawnee County, Nebraska.—Flight of swarms came from southeast.—[Several persons.

Tabor, Clay County, Kansas.—Saw a few migrating from the south at about 11 o'clock; not at all thick; none alighting. Weather clear; not very warm.—[C. H. Bagby.

Alma, Wabaunsee County, Kansas.—The locusts made their first appearance on Wednesday, 14th of June, flying from southwest to northeast, the wind having blown in the same direction at 30 miles to the hour at 2 o'clock p. m; from 800 to 1,000 feet high; very few came down; could not find one for examination. Weather warm and clear by 97° Fah.—[G. Zwanziger.

Manhattan, Riley County, Kansas.—Observed locusts while riding on the Atchison, Topeka and Santa Fé Railroad, between Newton and Larned, from 10 a. m. till 2 p. m., at a height perhaps of 1,000 feet, scattered over considerable space, but not numerous. Wind southwest, fresh, but not strong.—[L. R. Elliott.

Junction City, Davis County, Kansas.—Locusts flying north, some high, and some came

down 10 miles west of this place. South wind, but not very strong. Weather fine and warm.—[H. H. Mead.

Osborne City, Neosho County, Kansas.—The first grasshoppers from the south made their appearance to-day, flying over Osborne County. They appeared in considerable quantities at times and then would disappear; and at this time, 4 o'clock p. m., more are seen, indicating, I think, that the main body in the south are just about commencing their northern flight. They are traveling due north, the wind being strong in that direction.—[M. Mohler.

Patron, Butler County, Nebraska.—Few are flying, a little west of north; wind and weather favorable.—[John Tannahill.

Athol, Sioux County, Iowa.—From 11 a. m. to 3 p. m. swarms passing over, but few alighting; 'hoppers going north; wind south, 10 miles per hour. Calling the heaviest swarm 100, this would be about 10 in density. Height average. Thermometer 72° to 76°; few clouds.—[W. J. Newell.

June 15.

Athol, Sioux County, Iowa.—No 'hoppers; wind north.—[W. J. Newell.

Nebo, Platte County, Nebraska.—A quite dense flight of locusts passed over here from about 11 a. m. till 3 p. m., traveling a little west of north. Wind southwest; clear and warm, with a strong breeze. The flight was high and very few stragglers came down.—[John Wise.

June 16.

Athol, Sioux County, Iowa.—Flying a little east of north, with southwest wind at 12 miles per hour from 10 a. m. to 4 p. m. Density 20; height average. Thermometer 70° to 78°; clear.—[W. J. Newell.

Nebo, Platte County, Nebraska.—Locusts passing over from about 11 a. m. till 3 p. m., going a little west of north, with southwest wind. The flight is quite dense and high. Weather clear, warm, and with a strong breeze.—[John Wise.

Patron, Butler County, Nebraska.—A few locusts are passing over in the direction of a little west of north, with the wind and weather favorable.—[John Tannahill.

Guilford, Wilson County, Kansas.—Winged insects first began to migrate June 16 in small numbers.—[G. B. Brown.

June 16.

Lawrence, Douglas County, Kansas.—A very few locusts flying quite high in the air. They were so high that I was unable to say whether they were locusts or not.—[George F. Gaumer.

June 17.

Agenda, Republic County, Kansas.—Flying north; wind south.—[Stephen Bradley.

Athol, Sioux County, Iowa.—Locusts passed from 10.40 a. m. to 12.30 p. m.; wind south, 12 to 15 miles per hour; thermometer 76° to 82°; nearly clear; flight north; density 3; height not average. Nearly all those that alighted on the 16th rose and flew north.—[W. J. Newell.

June 18.

Agenda, Republic County, Kansas.—None flying; no wind; weather hot.—[Stephen Bradley.

Lawrence, Douglas County, Kansas.—To day the locusts have been flying in considerable numbers; they fly with the wind, which has been blowing steadily from south-southwest at the rate of about 40 miles per hour all day. I first observed them very high in the air at 11.45 a. m.; at that time only two or three could be seen at one time. The number steadily increased until 2.35 p. m., when hundreds of them could be seen at any time passing the sun. At 3.30 p. m. a few were seen flying in the lower air, within one hundred yards of the earth. At this time they were seen to drop to the earth, and continued to fall until 4.30 p. m. At 5 p. m. they ceased to fly, and probably averaged one to every square rod in the garden. They flew very swiftly and in straight lines in a north-northeast direction.—[George F. Gaumer.

June 19.

Agenda, Republic County, Kansas.—'Hoppers flying northwest; wind southeast; warm.—[Stephen Bradley.

June 20.

Agenda, Republic County, Kansas.—Flying northwest; wind southeast.—[Stephen Bradley.

Claytonville, Brown County, Kansas.—To-day is hot and the wind is strong; a great many are passing overhead, and I see my horses start two or three at almost every step through my corn-field.—[H. M. Robertson.

June 29.

Tabor, Clay County, Kansas.—Winged insects commenced migrating.—[J. H. Bagby.

Lane, Franklin County, Kansas.—Sky filled with locusts flying northwest, with a strong wind. In the evening a few came down.—[Jas. Hanway.

June 30.

Graham, Nodaway County, Missouri.—Grasshoppers flying in southeast direction at 3 p. m.; wind northwest; fly very high, and in considerable quantities.—[J. Morton.

Manhattan, Riley County, Kansas.—Noticed the first flight from my fields; wind northeast, consequently they went southwest.—[Solomon Whitney.

July 1.

Tabor, Fremont County, Iowa.—Toward noon they were rising very freely from our place; wind southeast.—[J. E. Todd.

Sheridan, Sioux County, Iowa.—Grasshoppers passed over here to-day at 11 o'clock, going northwest; wind blowing a gentle breeze from southeast. They were in large numbers, and flying high; some were alighting. We have large numbers of them here waiting a favorable wind to go; weather clear and warm.—[A. Edes.

July 2.

Tabor, Fremont County, Iowa.—Many in the air flying with the wind toward southeast.—[J. E. Todd.

Alma, Wabaunsee County, Kansas.—Locusts leaving, with a moderate northeast wind; weather clear; 90° Fah.—[G. Zwanziger.

July 3.

Tabor, Fremont County, Iowa.—Locusts moving north and northwest in great swarms.—[J. E. Todd.

Sarcofie, Jasper County, Missouri.—The grasshoppers are leaving, and are going in a northwest direction.—[E. D. Barton.

Claytonville, Brown County, Kansas.—The first flight that I am certain of was on the 3d July during a strong breeze from the south; since then the greater bulk of them have got their wings and are leaving at every favorable opportunity. Their course is northwesterly, but they never attempt to fly unless the day is warm and dry and a good breeze blowing from the southward.—[N. M. Robertson.

North Bend, Dodge County, Nebraska.—Noticed the first passing over at 11 a. m. to northwest, with a gentle breeze from southwest. They flew very high; swarms not dense; did not alight; weather warm and clear.—[C. C. Kendall.

July 5.

Tabor, Fremont County, Iowa.—Moving north and north by east. To-day they at times are about as thick as I have seen them here other years; moving north and north by west. There are comparatively few left here.—[J. E. Todd.

Russell, Russell County, Kansas.—Locusts have been so few that I did not think it worth reporting at all. They have been flying in the air in small quantities a few days in May and June, but not enough to make any note of. None have alighted here at all.—[Dr. H. A. Ellis.

July 5 *and* 6.

Nebo, Platt County, Nebraska.—Yesterday and to-day the 'hoppers are leaving us. All that are able to fly have done so; there are but very few left; their course is northwest; the wind east of south and south; fair breeze; dry and very warm. Thermometer standing 100° in the shade.—[John Wise.

July 7.

Oswego, Labette County, Kansas.—Those locusts that fly are governed entirely by the winds; they will fly only when it is in the right direction.—[C. C. Perkins.

July 8.

Yankton, Yankton County, Dakota.—The last few days flying 'hoppers have filled the sky in thin swarms. The natives mostly rose and went north with the wind. Prevailing breezes lately from south-southeast to north-northwest; moderate.—[A. W. Barber.

Belleville, Republic County, Kansas.—Many locusts were noticed on the wing for the past few days; not in large swarms, but have kept on passing at intervals; few have come to the ground. Wind south for the last three or four days.—[J. P. Heaton.

July 9.

Alma, Wabaunsee County, Kansas.—Locusts are passing with a moderate wind from northeast by north; weather clear; 90° Fahrenheit.—[G. Zwanziger.

July 11.

Cheyenne River Agency, Ashmore County, Dakota.—Swarms of locusts arrived at 10 a. m. in a westerly direction; not very dense; 300 feet high; 10 miles in depth and as far as the eye could reach in length; they did not stop. Wind west; weather warm and clear.—[J. F. Cravens, United States Indian agent.

July 12.

Milwaukee, Wisconsin.—Telegrams from points in Minnesota, Iowa, and Dakota report grasshoppers in large numbers flying with the wind. In Minnesota they are flying north, only a few alighting.—[Milwaukee Sentinel.

July 13.

Garden of Gods, Colorado.—Winged insects rising in Garden of Gods, sparsely; brisk wind from northwest.—[C. V. Riley.

Fort Walsh, British America.—Swarm dense, with the wind from the south-southwest; flying about 80 feet high. Weather clear; temperature 71°; light wind. A few alighted.—[J. G. Kittson.

July 14.

Denver, Arapahoe County, Colorado.—Flights first heard of at Wallon, Kansas, then at Julesburg, then lighting at Deadwood.—[C. V. Riley.

Denver, Arapahoe County, Colorado.—From 10 a. m. to 4 p. m., *spretus* flying southeastwardly at the rate of about 12 miles per hour. Wind moderate, from northwest. Swarms not dense and only seen looking into the sun. In one place, along Denver and Rio Grande Railroad, thick enough to cast shadow.—[C. V. Riley.

July 16.

Cheyenne River Agency, Ashmore County, Dakota.—Locusts coming back, going east at 11 o'clock a. m.; swarm quite dense—boundless. Wind east, slight; weather clear and warm.—[J. F. Cravens, United States Indian agent.

July 17.

Greeley, Colorado.—Flying northwest, sparsely; higher clouds from west.—[C. V. Riley.

July 18.

Norton, Norton County, Kansas.—The Rocky Mountain locusts made their appearance, going south; the wind blowing strongly from the northeast.—[Thomas Beaumont.

Lincoln, Dodge County, Nebraska.—The locusts were again flying over Lincoln to-day for three hours, going a little east of south. Have not been able to hear where they have alighted, though I have telegraphed and written in all directions. They appear to go in whatever direction the wind happens to be blowing, *and don't seem to wait this season until it blows in a certain direction.*—[Samuel Aughey.

July 20.

Norton, Norton County, Kansas.—The swarm of locusts which came on the 18th staid on the divide till to-day, when they left in a southwesterly direction.—[Thomas Beaumont.

Fort Walsh, British America.—Swarm very dense, with the wind from southeast, flying about 150 feet high. Weather clear; light wind; temperature 73°. Some alighted.—[J. G. Kittson.

Carroll, Carroll County, Iowa.—The 'hoppers have all gone, with the exception of a few late hatched ones.—[Andrew Beers.

July 21.

Bismarck, Dakota.—Flying northwest with the wind.—[George W. Sweet.

July 22.

Bismarck, Dakota.—Swarm very dense, with the wind from the northwest; flying about 200 feet high. Weather clear; brisk wind; temperature 68°. Very few alighted. Possibly this was the second swarm forced back by a contrary wind.—[J. G. Kittson.

Bismarck, Dakota.—Flying northwest with the wind.—[George W. Sweet.

Lincoln, Dodge County, Nebraska.—The locusts are again flying south, over Lincoln.—S. Aughey.

July 23.

Bismarck, Dakota.—Grasshoppers caught at Bismarck July 23.—[George W. Sweet.

July 25.

Graham, Nodaway County, Missouri.—There was no regular flight as in former years; they changed their course as the wind changed; seemed bewildered, having no definite direction to go, and think most relighted and perished here.—[J. Morton.

July 27.

Nebo, Platte County, Nebraska.—On Friday, July 27, the wind in the north, fair breeze, clear and warm, the 'hoppers moved southeast in a regular steady flight. At about 5 o'clock a slight shower came up, and the 'hoppers came down until it began to look rather dubious around the corn-fields and oat-patches.—[J. Wise.

July 28.

Sioux City, Woodbury County, Iowa.—Immense swarms of grasshoppers have been flying over in an easterly direction since morning; but few came down.—[Iowa Register.

July 29.

Sioux City, Woodbury County, Iowa.—Many 'hoppers leaving for the northeast; wind strong and south.—[J. Wise.

July 30.

Sioux City, Woodbury County, Iowa.—Many 'hoppers flying north, with a strong south wind.—[J. Wise.

July 31.

Nebo, Platte County, Nebraska.—Rainy; 'hoppers very stupid; could pick them up anywhere. Hundreds we bound up in the wheat, too stupid or helpless to get out of the way. The weather was sultry and light rain; cleared about 10 o'clock; warm.—[John Wise.

Norton, Norton County, Kansas.—To-day the wind is in the north, and the 'hoppers are going south, flying very high. They are not very numerous, however.—[Thomas Beaumont.

Adamson, Rooks County, Kansas.—The grasshoppers made their appearance here on July 31 in small quantities; came with a north wind, and left August 1; went southwest. The weather is cool and wet.—[Moses Adamson.

Council Bluffs, Pottawatomie County, Iowa.—At Council Bluffs locusts were passing south in small swarms in the afternoon.—[J. E. Todd.

August 1.

Tabor, Tremont County, Iowa.—To-day they have been passing in dense swarms (as thick as I have ever seen them, I think) slowly to the southwest. If there is not a hard north or northwest wind soon, we may have plenty of them down upon us again.—[J. E. Todd.

Norton, Norton County, Kansas.—A few passed over, going southeast.—[Thomas Beaumont.

August 1–3.

Nebo, Platte County, Nebraska.—'Hoppers went west on these three days, till but few were left. Wind southeast, with gentle breeze.—[John Wise.

August 3.

Norton, Norton County. Kansas.—A flight went over, flying very high and going in a southwest direction.—[Thomas Beaumont.

August 5.

Norton, Norton County, Kansas.—A great many locusts passing over in a southwest direction.—[Thomas Beaumont.

August 6.

Norton, Norton County, Kansas.—There are very few in the air.—[Thomas Beaumont.

Medary, Brookings County, Dakota.—Wind northwest; great swarms passing south, augmented by risings from the prairies.—[Rev. G. S. Codington.

Claytonville, Brown County, Kansas.—Locusts are nearly all gone.—[W. M. Robertson.

August 7.

Logan, Phillips County, Kansas.—Locusts are passing over this place, going in a southerly direction; wind in the north; not as many passing as last year at this time; very few went north this spring.—[J. W. Benjamin.

August 8.

Medary, Brookings County, Dakota.—Light swarms of locusts move south; wind strong from the northwest.—[Rev. G. S. Codington.

August 10.

Norton, Norton County, Kansas.—Locusts were going north in the forenoon, and in the afternoon the wind got in the west and they went east, a few alighting on the divide.—[Thomas Beaumont.

August 11.

Norton, Norton County, Kansas.—The air is full of locusts going southeast, flying very high.—[Thomas Beaumont.

August 11 *and* 12.

Patron, Butler County, Nebraska.—Locusts on the wing; wind north.—[John Tannahill

August 12.

Norton, Norton County, Kansas.—The air was literally full of locusts, going a little west of south.—[Thomas Beaumont.

August 13.

Norton, Butler County, Nebraska.—Some very heavy clouds of locusts passed over here to-day in the forenoon, but when night came there were not enough to notice.—[John Tannahill.

Norton, Norton County, Kansas.—The divide between the Prairie dog and the Sapper was literally covered with locusts at 9 o'clock, and at 10.35 a gust of wind came from a little west of north, when the whole of them rose and started off on their southern tour.—[Thomas Beaumont.

Tabor, Clay County, Kansas.—Some swarms passing over in a southerly direction; wind northeast, slow; quite warm; clear; some few came down.—[J. W. Bagby.

Alma, Wabaunsee County, Kansas.—To-day locusts have gone over Alma, not very thickly, flying; coming from northeast and going southwest.—[G. Zwanziger.

August 14.

Alma, Wabaunsee County, Kansas.—A few have gone the same direction as those of yesterday.—[G Zwanziger.

August 15.

Tabor, Clay County, Kansas.—Wind changed to south, and those which passed over on the 13th came back with the wind and went toward the northwest; the few that lit on the 13th started off also in the same direction at 2 p. m.—[J. W. Bagby.

August 27.

Little Sioux, Harrison County, Iowa.—Tremendous swarm made its appearance, coming from the south. This was at about 11 a. m. Soon the heavens were clouded with them; the air was full; all hurrying on northward. About 2 p. m. the wind changed and blew from the north. Goodness! what a change. In an instant they commenced dropping all around and upon us, and by 4 p. m. the entire surface of the ground, the fences, and the houses were covered. The corn was bent down, the trees hung loaded as with swarms of bees; it seemed as if they were about to take every green and dry thing.—[A. H. Gleason.

August 30.

Little Sioux, Harrison County, Iowa.—The wind changed and blew from the north, when about 10 a. m. they commenced rising, and by 2 p. m. scarcely a locust could be seen, they having all gone back in the direction they came from.—[A. H. Gleason.

September 16.

Camp Supply, Cherokee Nation, Indian Territory.—Grasshoppers are flying over in great numbers; they come from the northwest and go southeast; none alight. The wind is from the south changing to a norther toward evening.—[T. E. Wilcox.

September 17.

Ellis, Ellis County, Kansas.—Locusts are moving west-northwest.—[L. Watson, M. D.

September 22.

Ellis, Ellis County, Kansas.—Gentle northwest wind; locusts moving southeast.—[L. Watson, M. D.

September 24.

Adamson, Rooks County, Kansas.—Grasshoppers have been flying in small numbers nearly all the time. They go any way the wind blows. They have been on the wing in small quantities ever since July 31. The careless observer would say there are none here.—[Moses Adamson.

September 27.

Ellis, Ellis County, Kansas.—Locusts flying first south and then south-southwest; wind gentle, northwest, then north, and then north-northeast; temperature at 8 p. m. 58°.—[L. Watson, M. D.

October 8.

Ellis, Ellis County, Kansas.—Some were observed down. The wind on that and preceding day being a gentle northwest. On the 6th there was a gentle southeast wind with slight rain; temperature in the morning 53°.—[L. Watson, M. D.

October 21.

Ellis, Ellis County, Kansas.—Locusts moving southerly; temperature in morning 26°, being the first hard frost. Very gentle northerly wind; day temperature not observed. Another hard frost that night, with a calm morning.—[L. Watson, M. D.

October 22.

Ellis, Ellis County, Kansas.—Few locusts flying northeast. Wind southwest; temperature 65°.—[L. Watson, M. D.

October 23.

Ellis, Ellis County, Kansas.—Few locusts moving northeast.—[L. Watson, M. D.

October 25 and 26.

Ellis, Ellis County, Kansas.—A few were observed. Wind gentle, southwest. Temperature on the 26th, at 5 p. m., 64°.—[L. Watson, M. D.

[☞ The following data are more particularly from Minnesota and the northern portion of the locust area. Whenever the State or Territory is not indicated, Minnesota is to be understood:]

1877.

June 14.

Medary, Brookings County, Dakota.—Morning, wind west; changed to southwest; a few fly.

Kasota, Le Sueur County.—First noticed flying.

Kanaranzie, Rock County.—Seen here; go north.

Lake Crystal, Blue Earth County.—Winged locusts seen; reported flying.

Nebo, Platte County, Nebraska.—Locusts flying until 3 p. m., going west of north; wind strong from southwest; weather clear and warm.

Schuyler, Colfax County, Nebraska.—Flying northward; wind from south. Flying northward from extreme southeast corner of Dakota to Le Mars, in Plymouth County, Iowa.

June 15.

Saint Wendall, Stearns County.—First winged seen.

Bondin, Murray County.—About the 15th a few went north.

Magnolia, Rock County.—Flew north.

Nashville, Martin County.—Flying in a southerly direction very heavily.

June 16.

Medary, Brookings County, Dakota.—Morning, wind northwest; some swarms seen going east.

Magnolia, Rock County.—Flying north.

Dell Rapids, Minnehaha County, Dakota.—Wind south; some seen.

Luverne, Rock County.—Going north; a few lit here and there.

Worthington, Nobles County —Wind strong, south to southwest; some fly high.

Bigelow, Nobles County.—Heavy flight north and northeast, 11 a. m., 15 miles per hour.

Seward, Nobles County.—Fly thick northwest from 10 to 4 o'clock.

Little Rock, Nobles County.—Fly north; a few lit.

Adrian, Nobles County.—About the 16th fly over to north, a few alighting.

Stevens, Morris County.—Flew very high; think they went southeast.

Milltown, Armstrong County.—Warm, clear; wind toward north. At 12 m. swarms passing in large numbers and very high; were two and a half days passing.

Murray County.—Flying north.

June 17.

Luverne, Rock County.—Going north, a few alighting here and there.

Bigelow, Nobles County.—Heavy flight going north and northeast; wind southwest.

Magnolia, Rock County.—Heavy flight going north.

Morris, Stevens County.—Fly very high, going southeast.

Fergus Falls, Otter Tail County.—Fly over to north; *vid.* 18th.

Olivet, Hutchinson County, Dakota.—Fly northward from 11 a. m. to 3 p. m.; wind south; weather clear; 20 miles per hour.

Murray County.—Going north.

June 18.

Worthington, Barnes County, Dakota.—A few were flying from south.

Fergus Falls, Otter Tail County.—Wind changed; *vid.* 17th; flying back.

Marshall, Lyon County.—Full-fledged locusts found this morning; must have alighted; were flying from south yesterday.

New Ulm, Brown County.—First seen flying southeast.

Hale, McLeod County.—First winged seen.

Worthington, Nobles County.—Wind northwest; a few fly at noon.

Sauk Rapids, Benton County.—Commenced taking a flight to southeast.

Saint Cloud, Stearns County.—Commenced flying.

Monticello, Wright County.—Fly over from the northwest.

Madelia, Watonwan County.—Northwest.

Renville County.—South-southeast.

Sherburne County.—South-southeast.

June 19.

Linden, Brown County.—Wind south; first seen flying northwest.

Severance, Sibley County.—First seen flying.

Saint Peter, Nicollet County.—First hatch getting wings.

New Ulm, Brown County.—Change of wind, fly west.

Madelia, Watonwan County.—Seen flying.
Beaver, Renville County.—Fly over in considerable numbers, westerly.
Sibley, Sibley County.—Flying southwest from 10 to 3. Daily flights same hour to July 8.

June 20.

Newberg, Traill County, Dakota.—A few lit from south, not enough to do damage, and not gone July 10.
Forestburg, Bramble County, Dakota.—Wind north, fly south.
Appleton, Swift County.—First seen flying.
Tenhassen, Martin County.—First winged seen.
Redwood Falls, Redwood County.—Flying southeast.
Bismarck, Burleigh County, Dakota.—Flying to northwest at 11 a. m. Wind southeast; moderate breeze.

June 21.

Saint Wendall, Stearns County.—First seen flying.
Benson, Swift County.—First seen flying.
Lake Lillian, Kandiyohi County.—First seen flying.
New London, Kandiyohi County.—First seen flying, going southeast.
Renville, Renville County.—Four sizes of 'hoppers in this locality from one-quarter in length upward; hatch does not appear to be completed yet.
Bismarck, Burleigh County, Dakota.—Flying northwest; wind southeast.

June 22.

Gary, Deuel County, Dakota.—First seen flying; could hardly be seen; going very high to the southeast.
Saint Wendall, Stearns County.—Flying northwest.
Paynesville, Stearns County.—Some of our hatch went west.
Fairhaven, Stearns County.—Began to fly; went northwest.
Benson, Swift County.—Wind southeast; fly northwest.
Litchfield, Meeker County.—First flight; went northwest.
Corinna, Wright County.—Began to fly from here; went west on a strong east wind.
Severance, Sibley County.—Flying.
Mankato, Blue Earth County.—Took flight; west.
Madelia, Watonwan County.—First winged seen; some flying north.
New London, Kandiyohi County.—Going southeast.
Bismarck, Sibley County.—A dense swarm going northwest; flying very high at 5 to 10 miles per hour; wind southeast.
New Auburn, Sibley County.—Flying high to northwest from 9 a. m. to 4 p. m.; wind from southeast.
Bismarck, Dakota.—Hoppers left, having done but little damage.

June 23.

Gary, Deuel County, Dakota.—Same as 22.
New London, Kandiyohi County.—Going west.
Madelia, Watonwan County.—Some going north.
Morristown, Rice County.—First fly; wind northwest, rather still; quite warm; going southeast at 2 p. m.

June 24.

Saint Wendall, Stearns County.—Going east in great numbers.
Benson, Swift County.—Go east; wind west; a few alighting.
New London, Kandiyohi County.—Go southeast.
Litchfield, Meeker County.—Go west; a few have been seen coupling.
Corinna, Wright County.—More left, vid. 22; go south nearly.
Madelia, Watonwan County.—The early hatched getting wings.
Bigelow, Nobles County.—First winged seen.

June 25.

Saint Wendall, Stearns County.—Fly northwest sparingly.
Paynesville, Stearns County.—Fly northwest in considerable numbers.
Alexandria, Douglas County.—Fly northwest.
New London, Kandiyohi County.—Fly west.
Willmar, Kandiyohi County.—Fly west.
Manannah, Meeker County.—Commenced raising.
Marshall, Lyon County.—Fly north; very few.
Monticello, Chippewa County.—First seen flying southeast.
Beaver Falls, Renville County.—Fly northwest; air full.
Linden, Brown County.—Fly southeast; wind northwest.
Vicksburg, Renville County.—Fly northwest; wind southeast.
Hale, McLeod County.—Fly northwest; few.
Madelia, Watonwan County.—Fly west; not plenty.

Pringhar, O'Brien County, Iowa.—Light swarms flying to northwest; weather clear, with south and southeast wind.
Hector, Renville County.—Fly northwest.
Osakis, Douglas County.—Fly northwest.

June 26.

Saint Wendall, Stearns County.—Fly southeast; few.
Holmes City, Douglas County.—Fly southeast; wind northwest.
Willmar, Kandiyohi County.—Fly southeast; very high and numerous.
New London, Kandiyohi County.—Fly southeast.
Manannah, Meeker County.—Alighting.
Delano, Wright County.—Fly southeast.
Marshall, Lyon County.—Fly south.
Beaver Falls, Renville County.—Fly south; a few alighting.
Vicksburg, Renville County.—Fly southeast; wind northwest.
Saint Peter, Nicollet County.—Fly southeast.
Morristown, Rice County.—Fly quite numerously.
Tenhassen, Martin County.—Fly east; some wind west.
Lincoln, Lancaster County, Nebraska.—Flying northeast; heavy rains.
Kerkhoven, Swift County.—Flying northwest at 9 a. m.; quite low; wind southeast; weather dry and clear.

June 27.

Holmes City, Douglas County.—Wind northwest; go southeast.
Vicksburg, Renville County.—Rainy; none fly.
Saint Peter, Nicollet County.—Air full; go west; largest flight seen yet.
Hale, McLeod County.—Moderate wind from northwest; going southeast; 'hoppers rose in clouds and left.
Madelia, Watonwan County.—Going north.
Luverne, Rock County.—Swarms very high; go southwest.
Delafield, Jackson County.—Go northwest; not very numerous; a few leave.
———, *Jackson County.*—Go nearly north; not numerous.
Middletown, Jackson County.—Go north; few; very high.
The accounts for this date are confused; wind must have been changeable or very light.
Lincoln, Lancaster County, Nebraska.—East of north, heavy.
Excelsior, Hennepin County.—A thin flight at 9 a. m.

June 28.

Long Prairie, Todd County.—Wind west-northwest; clear and cool; first flight; with wind; moderate numbers.
Burnhamville, Todd County.—Some passed east-southeast; some of ours left.
Saint Cloud, Stearns County.—Air full, going southward and eastward.
Fairhaven Stearns County.—Some of our hatch went nearly south.
Saint Wendall, Stearns County.—Many fly southeast.
Benson, Swift County.—Wind north; a few fly south; a few came down in some parts of the county.
Lake Elizabeth, Kandiyohi County.—Came from northwest and alighted.
Willmar, Kandiyohi County.—Fly southeast for three days past; clouds seem to rise and leave on 27th.
Litchfield, Meeker County.—Fly east at 12 m.; very high.
Dassel, Meeker County.—Fly southeast; few.
Corinna, Wright County.—In vast numbers from 12 m. to 2 p. m.; southeast; very high.
Clearwater, Wright County.—An extra flight go in south direction; advance passed at M.; many joined from here.
Granite Falls, Yellow Medicine County.—Air filled all day; go little south of east; rising from here in large numbers.
Lac-qui-Parle, Lac-qui-Parle County.—Go southeast; slight movement.
Baxter, Lac-qui-Parle County.—Go southeast in quite large quantities, leaving here in considerable numbers.
Vicksburg, Renville County.—Cloudy in the a. m.; at noon wind and 'hoppers from northwest.

June 29.

Benson, Swift County.—Cloudy.
Dassel, Meeker County.—Wind east; strong; few rise and fly.
Silver Creek, Wright County.—Quite a number in the air for the last seven or eight days; go southeast.
Granite Falls, Yellow Medicine County.—Strong wind from southeast all day, but few fly and few rising.
Baxter, Lac-qui-Parle County.—Wind southeast; none fly.

Vicksburg, Renville County.—Cloudy; wind southeast; none fly.
Ridgeley, Nicollet County.—Fly northwest in great numbers; most of the hatch gone northwest
Kanaranzie, Rock County.—Go north; a few; a few alighting.
Little Rock, Nobles County.—A few stragglers lit from south; wind strong.
Delafield, Jackson County.—Wind south; go north; a few alighting.
Lemars, Plymouth County, Iowa.—Fly northwest.
Paynesville, Stearns County.—Immense swarms go southeast; many alight. Many of our hatch rose from 11 a. m. to 3 p. m.
Lane, Franklin County, Kansas.—Flying northwest; few alighting.

June 30.

Benson, Swift County.—Cloudy.
Granite Falls, Yellow Medicine County.—Wind west; blew hard; none fly; none rising.
Baxter, Lac-qui-Parle County.—Cloudy; wind northwest; none.
Vicksburg, Renville County.—Wind northwest; a few fly.
Ridgeley, Nicollet County.—Cool; wind northwest; none fly.
Manhattan, Riley County, Kansas.—Fly southwest; wind northeast.
Lake Village, Brookings County, Dakota.—Flying high, four miles per hour; wind east.

July 1.

Forestburg, Bramble County, Dakota.—Wind southwest and southeast; eight swarms go north about noon.
Rockport, Hanson County, Dakota.—Wind southeast; fly very high from 1 to 4 p. m. A driving shower of rain caused many to alight on west bank of James River.
Sioux Falls, Sioux County, Dakota.—Large quantities flew over northwest; about 3 o'clock wind changed and slight rain caused a few to drop.
Osakis, Douglas County.—Fly east in large swarms.
Brandon, Douglas County.—Fly southeast.
Holms, Douglas County.—Flying southeast in small quantities.
Burnhamville, Todd County.—Passed over in southerly direction; swarm not very extensive.
Round Prairie, Todd County.—Commenced to fly south-southeast.
Long Prairie, Todd County.—Light wind from west; partly clear; fly southwest in moderate numbers.
Fairhaven, Stearns County.—Fly southeast very thick; none alighted; between 3 and 4 they stopped flying.
Paynesville, Stearns County.—Fly southeast very slow; circling about in the air in great numbers; wind changed to southwest.
Clear Lake, Sherburne County.—Go south; wind north.
Saint Wendall, Stearns County.—Southeast a. m., and northwest p. m.
Benson, Swift County.—Go south a. m., west in p. m.; not a great many.
Appleton.—In the sky in vast numbers; did not seem to go either way.
Willmar, Kandiyohi County.—Slight wind; go south; immense numbers; move slow.
Albion, Wright County.—Some alighted; left on the 3d.
Corinna, Wright County.—Fly very thick southwest.
Silver Creek.—Fly very thick southeast.
Lac-qui-Parle, Lac-qui-Parle County.—Go southeast until 11 o'clock; then wind changed to southeast, and they went northwest.
Baxter, Lac-qui-Parle County.—Slight wind; large numbers high up, at 2 p. m.; wind from southeast; fly northwest.
Granite Falls, Yellow Medicine County.—Air full; large numbers; rise and go northeast.
Brookfield, Renville County.—Large swarms fly with the east wind.
Vicksburg, Renville County.—Very hot and still; locusts rising, circling, and alighting; main body go southeast.
Hale, McLeod County.—Large swarms go southeast.
Penn.—Gentle breeze; locusts go south; many drop; light on the 3d.
Cottonwood, Brown County.—In the air very thick.
Albion, Wright County.—First seen in any great numbers; came from east; many stopping.
Linden, Brown County.—Large numbers; go southwest.
Ridgeley, Nicollet County.—Fly west in great numbers.
Long Prairie, Todd County.—Fly east; quite a number alighted.
Union Center, Le Sueur County.—Fly north.
Morristown, Rice County.—Began to fly; wind northwest; clear; light clouds.
Windom, Cottonwood County.—Fly southeast in a. m.; a little west of south in p. m.
Mankato, Blue Earth County.—Sky alive with them; seem to tend southeast in a. m. and southwest in p. m.; hard to determine their course.

Madelia, Watonwan County.—Vast clouds go south in a. m., due west in p. m.
Butterfield, Watonwan County.—Wind very slight from southeast; fly very high—northwest; very few, if any, alighted.
Luverne, Rock County.—Those hatched here rise and go northwest.
Kanaranzie, Rock County.—Hatch leaving for northwest; air full, going same way.
Township 103, *range* 47, *Rock County.*—Small flight.
Clinton, Stanton County, Nebraska.—Wind southeast; go northwest; large swarms; a few dropped.
Beaver Creek, Rock County.—A heavy swarm of the hatch took flight to the northwest.
Magnolia, Rock County.—Go northwest; many leaving.
Worthington, Nobles County.—Fly west and northwest; high; at sunset some lit near here. Some lit in the county.
Adrian, Nobles County.—Some passing nearly north most of the day.
Delafield, Jackson County.—Fly west.
Jackson, Jackson County.—Fly west.
Heron Lake, Jackson County.—First seen here flying.
Minnesta, Jackson County.—Go north; very many; very high; some leaving.
Christiana, Jackson County.—First seen flying.
Fairmount, Martin County.—Stiff, northeast breeze; went with wind.
Fox Lake, Martin County.—Wind southeast; go northwest; quite a movement, but not very heavy.
Center Creek, Martin County.—Go southwest; air full.
Tabor, Fremont County, Iowa.—Rising and flying southeast toward noon.
Sheridan, Sioux County, Iowa.—Large numbers flying high to northwest at 11 p. m. Some alighting.
Dawson County, Nebraska.—Seen flying.
Grafton, Sibley County.—Weather warm; wind northeast. Locusts flying southwest at 12 m.
Bigelow, Nobles County.—Flying west at 20 miles per hour from 11 a. m. to 4 p. m. Wind from east.
Lincoln, Lancaster County, Nebraska.—Seen.

July 2.

Medary, Brookings County, Dakota.—None of any consequence for last two weeks. Wind south, light; and light swarms moving north.
Forestburg, Bramble County, Dakota.—Wind north; 'hoppers returned; none alighted.
Rockport, Hanson County, Dakota.—Wind west-northwest; high; a few seen from 11 to 12.30.
Round Prairie, Todd County.—Wet and cloudy; none move.
Benson, Swift County.—Fly south in small numbers.
Lac-qui-parle, Lac-qui-parle County.—Slight move to northwest.
Baxter, Lac-qui-parle County.—Stiff wind from northwest; few fly southeast; some leave.
Granite Falls, Yellow Medicine County.—Air full; going east; others rise and go east; none alighted yet.
Montevideo, Chippewa County.—Wind northwest; went southeast.
Corinna, Wright County.—Numbers quite small.
Vicksburg, Renville County.—Southeast wind and cloudy in a. m.; at m. wind west.
Cottonwood, Brown County.—Fly northeast.
Linden, Brown County.—Wind northwest; none seen.
Little Prairie, Nicollet County.—Fly southeast; quite a number alighting.
Ridgeley, Nicollet County.—Wind west; but flew fly; some of them alighted
Pipestone, Pipestone County.—Fly southeast; very high.
Lowville, Murray County.—Go northwest.
Windom, Cottonwood County.—Fly west; very high.
Riverdale, Watonwan County.—First flight.
Butterfield, Watonwan County.—Wind from north; none seen.
Kanaranzie, Rock County.—Go east; *vid.* 7th.
Bigelow, Nobles County.—Wind west; cool; cloudy; few fly east.
Adrian, Nobles County.—Some fly from east (?).
Tenhassen, Martin County.—Few go east.
Jo Davis, Faribault County.—No flight in swarms yet.
La Platte, Sarpy County, Nebraska.—Flying east of north.
Tabor, Fremont County, Iowa.—Flying northwest; wind southeast.

July 3.

Yellow Banks, Deuel County, Dakota.—First appearance; only a few going west at m.
Gray, Deuel County, Dakota.—Fly west.
Medary, Brookings County, Dakota.—Wind south; stronger; light swarms go north.
Dell Rapids, Minnehaha County, Dakota.—Wind southeast; quite a number alighted.
Forestburg, Bramble County, Dakota.—Cloudy; none seen.

Rockfort, Hanson County, Dakota.—Southeast wind; fly very high and numerous.
Elbow Lake, Grant County.—Wind southeast; considerable numbers go northwest.
Herman, Grant County.—Go northwest on 3d, 4th, and 5th—most on 4th.
Brandon, Douglas County.—Fly west; air full of them.
Burnhamville, Todd County.—Some left to west-southwest.
Round Prairie, Todd County.—Raised in great numbers and went west-southwest.
Long Prairie, Nicollet County.—Wind east, partly clear; fly with wind in moderate numbers.
Morris, Stevens County.—Began to fly at 9; go west; wind southeast, clear and warm; began to alight about 1 o'clock.
Westport, Pope County.—Fly little south of west; extensive movement; very high.
Fair Haven, Stearns County.—Go southwest in great numbers.
Paynesville, Stearns County.—Go west very thick; many of ours joined them; many came down, but rose again mostly.
Saint Wendall, Stearns County.—Go west, many.
Clear Lake, Sherburne County.—Wind northwest; go southeast.
Ortonville, Big Stone County.—First seen; a few go west.
Lac-qui-Parle, Lac-qui-Parle County.—Go northwest; immense quantity.
Baxter, Lac-qui-Parle County.—Wind little south of east; good breeze; large numbers go northwest.
Montevideo, Chippewa County.—Wind southeast; fly very thick northwest.
Dassel, Meeker County.—Warm, bright; wind easterly, very light; went southwest till 1.30, then west; large swarms rise and a continuous line passed from 11 to 3.
Manannah, Meeker County.—Upper flight west of southwest; lower flight west.
Corinna, Wright County.—Go due south; air seemed full as far as the eye could reach.
Cokato, Wright County.—Took flight.
Stockholm, Wright County.—Commenced flying to west.
Granite Falls, Yellow Medicine County.—Come down in small swarms at 11; at 12, rising and air full; go northwest.
Beaver, Renville County.—Go northwest. During a greater part of the day, a swarm as innumerable as the sands on the shore took its flight over this section, going in a westerly direction.
Vicksburg, Renville County.—Morning cloudy; clear at noon; wind east by southeast; 'hoppers go with wind.
Palmyra, Renville County.—Go westerly; high.
Brookfield, Renville County.—Southeast wind; swarms go west and southwest.
Hale, McLeod County.—Wind southeast; immense swarms go with wind.
Penn, McLeod County.—Those that lit on 1st left, going northwest.
Marshfield, Lincoln County.—Go northwest; first swarm seen; light movement.
Marshall, Lyon County.—Go west freely; in the evening alighting.
Tracy, Lyon County.—Go west; did not alight.
Charleston, Redwood County.—Go west-northwest; high and very fast from 12 to 3.30; first flight.
Walnut Station, Redwood County.—Small flight to west and northwest, from 11 to 2.30; a few alighted.
Lamberton, Redwood County.—3d, 4th, 5th, and 6th, came in with east-southeast wind.
Cottonwood, Brown County.—Go southwest in a. m. and northwest in p. m.
Linden, Brown County.—Wind south; *vid.* 5th.
Albin, Brown County.—Fly west; wind east.
Saint Peter, Nicollet County.—Large flight southwest.
Ridgely, Nicollet County.—Fly west in great numbers; our own go with them.
Currie, Murray County.—Fly west.
Windom, Cottonwood County.—Fly west; very high.
Butterfield, Watonwan County.—Light southeast wind; 'hoppers commenced passing over; many alighted.
Madelia, Watonwan County.—Continuous flight all day to a little south of west; those of ours that had wings joined them.
Luverne, Rock County.—Go a few degrees west of north in considerable numbers.
Kanaranzie, Rock County.—Go northwest; *vid.* 7th.
Township 103, *range* 47, *Rock County.*—Go northwest.
Bigelow, Nobles County.—Clear; light southeast wind; fly thick from 11 to 4.
Worthington, Nobles County.—Fly northwest at noon, quite heavy.
Graham Lake, Nobles County.—Large numbers go west; few came down.
Adrian, Nobles County.—Some fly; a few alighted.
Delafield, Jackson County.—Wind south of east; go northwest; mostly very high; none alighted.
Christiana, Jackson County.—Go little north of west; a few alighted about 3 p. m.
Tenhassen, Martin County.—Wind south-southeast, moderate, very warm; fly northwest.
Claytonville, Brown County, Kansas.—Go southwest; wind northeast.

La Platte Valley, Nebraska.—Flying east of north; heavy rains.
Omaha, Nebraska.—Flying very high to northwest at 11 a. m.; wind southeast; clear.
Tabor, Fremont County, Iowa.—Go north and northwest.
Pipestone, Pipestone County.—Go southwest at 10 a. m., none alighting.
Big Stone Lake, Pipestone County.—Go northwest, many alighting.

July 4.

Yellow Banks, Deuel, Dakota.—Wind east; very warm; go west about noon; pretty thick; high.
Gray, Deuel County, Dakota.—Wind east; fly west; high; none lit yet.
Medary, Brookings County, Dakota.—Wind southeast; some fly with wind; a few stragglers alight; *Astoma gryllaria* quite numerous.
Dell Rapids, Minnehaha County, Dakota.—Wind southeast; quite a number lit.
Forestburg, Bramble County, Dakota.—Wind south; plenty flying; very high.
Rockport, Hanson County, Dakota.—Wind southeast; alight on upland west of town.
Detroit, Becker County.—Few fly southeast; ours have not left yet.
Elbow Lake, Grant County.—Still go northwest.
Herman, Grant County.—*Vid.* 3d.
Morris, Stevens County.—Saw them early this a. m.; very clear; clouded over about 11 and they began to alight; at 1 p. m. thick; wind southeast; go northwest; at 4 p. m. they cover the ground.
Westport, Pope County.—Extensive movements to little south of west; very high.
Saint Cloud, Stearns County.—Fly west.
Elk River, Sherburne County.—Those hatched here went south by southeast.
Benson, Swift County.—Very thick northwest.
Lac-qui-Parle, Lac-qui-Parle County.—Go northwest; immense quantities.
Baxter, Lac-qui-Parle County.—Go northwest; very large quantities; wind southeast.
Montevideo, Chippewa County.—Wind southeast; fly northwest; very thick.
Lake Lillian, Kandiyohi County.—Go northwest.
Chatham, Wright County.—Begin to leave; go southwest.
Corinna, Wright County.—Very few move.
Monticello, Wright County.—Flew away by millions.
Granite Falls, Yellow Medicine County.—At 1 o'clock 'hoppers rising and air full; go northwest.
Canby, Yellow Medicine County.—Wind southeast; a few fly; very few alighted.
Beaver Falls, Renville County.—Air full; go west; another large invoice fly northwest; large numbers in this vicinity rise and join them.
Vicksburg, Renville County.—Very hot wind southeast.
Brookfield, Renville County.—Swarms go west; southeast wind; fly northwest very thick; at 4 p. m., dropping down on everything.
Palmyra, Renville County.—Go westerly; high.
Severance, Sibley County.—Air full.
Marshall, Lyon County.—Few go west; some lit.
North Hero, Redwood County.—Alighted; seemed to come from west.
Lamberton, Redwood County.—*Vid.* July 3.
Cottonwood, Brown County.—Go northwest; all gone that have wings.
Linden, Brown County.—Wind east; *vid.* July 5.
Albin, Brown County.—Fly northwest; wind southeast.
Ridgeley, Nicollet County.—Fly west; many of ours going; not as thick in the air as on previous days.
Long Prairie, Nicollet County.—Fly west.
Currie, Murray County.—Fly north.
Butterfield, Watonwan County.—Light southeast wind; still go over; many more alighted.
Kanaranzie, Rock County.—Go northwest; *vid.* July 7.
Worthington, Nobles County.—Fly northwest; high.
Bigelow, Nobles County.—Wind south; light clouds; none seen till 2.30, then go north.
Adrian, Nobles County.—Some fly west; few alighted.
Delafield, Jackson County.—Wind southeast; go northwest; none alighted.
Tenhassen, Martin County.—Wind south; hot, cloudy; not many fly.
Fox Lake, Martin County.—Go northwest; quite a movement, but not very large.
Tabar, Fremont County, Iowa.—Go south.
Schuyler, Colfax County, Nebraska.—Flying.

July 5.

Sisseton Agency, Dakota.—*Vid.* letter.
Yellow Banks, Deuel County, Dakota.—Wind east; warm; a few go west; high.
Medary, Brookings County, Dakota.—Same as 4th; northwest.
Forestburg, Bramble County, Dakota.—Wind south and southeast; plenty fly all day; began to light about 3; *vid.* 6th.

Rockport, Hanson County, Dakota.—Wind southeast; 96° in shade; wind 3 miles per hour; fly in large numbers from 11 to 6.
Parker's Prairie, Otter Tail County.—Fly west or northwest; not in great numbers.
Scambler, Otter Tail County.—West; commenced flying.
Ebon Lake, Grant County.—No wind; plenty go south.
Herman, Grant County.—*Vid.* 3d.
Alexandria, Douglas County.—Fly southwest.
Holmes City, Douglas County.—Fly west; wind southeast.
Long Prairie, Todd County.—Wind north; clear and warm; fly with wind, thick and high; our main body left to-day.
Burnhamville, Todd County.—Some left south-southwest.
Morris, Stevens County.—Moving northwest all day; some coming down.
Westport, Pope County.—Extensive move to little south of west; very high.
Oscar Lake, Pope County.—Fly west for last 4 days; thick on 4th and 5th.
Paynesville, Stearns County.—Go west in great numbers; many left us; from 10 to 4.
Fairhaven, Stearns County.—Go southwest in great numbers.
Saint Wendall, Stearns County.—Go nearly west; heaviest flight so far.
Saint Cloud, Stearns County.—Clouds in air; go southeast.
Clear Lake, Sherburne County.—Wind northeast; go southwest; our own join as fast as winged.
Elk River, Sherburne County.—Hatch went south by southeast; none passing except those hatched here.
Ortonville, Big Stone County.—Swarming in the air from 10 to 4; alighted in large numbers in this county.
Benson, Swift County.—Still go northwest in countless numbers.
Kerkhoven, Swift County.—Fly west; come down in large numbers.
Lac-qui-Parle, Lac qui-Parle County.—Fly northwest very thick.
Baxter, Lac-qui-Parle County.—Fly northwest; wind southeast; all that could fly left here.
Montevideo, Chippewa County.—Winds east-southeast; fly high and very thick northwest.
Lillian, Kandiyohi County.—Fly northwest.
Swede Grove, Meeker County.—Fly west in great numbers.
Mananah, Meeker County—Fly west, many rising.
Monticello, Wright County.—Flew away by millions.
Cokato, Wright County.—Took flight.
Montrose, Wright County.—Fly southwest in great numbers.
Silver Creek, Wright County.—About three-fourths have taken wing and gone in a southeast direction.
Corinna, Wright County.—Many fly up from fields, swarming like bees.
Granite Falls, Yellow Medicine County.—One o'clock; go west, air full.
Beaver Falls, Renville County.—Air full; go west.
Vicksburg, Renville County.—Morning cloudy; wind north; fly east-southeast, settling at 4.
Brookfield, Renville County—Swarms go west; southeast wind.
Penn, McLeod County.—Fly northwest.
Glencoe, McLeod County.—Fly little south of west nearly all day.
Severance, Sibley County.—Air full.
Shakopee, Scott County.—Commenced to fly; go southwest.
Blakeley, Scott County.—Fly west and northwest in clouds from 11 to 4; none dropped.
Tracy, Lyon County.—Go west, few alighting.
Marshall, Lyon County.—Fly northwest.
Walnut Station, Redwood County.—Heavy swarms go northwest from 10.30 to 2.30; drop quite thick in places.
Lamberton, Redwood County.—*Vid.* July 5.
Albin, Brown County.—Fly west.
Linden, Brown County.—East wind on 3d, 4th, and 5th took most of them away.
Cottonwood, Brown County.—Go west.
L. Prairie, Nicollet County.—Fly west.
Ridgeley, Nicollet County.—Wind northeast; cloudy; none seen.
Lowville, Murray County.—Fly northwest.
Ben Franklin, Murray County.—Fly northwest; first seen yet; quite large quantity.
Currie, Murray County.—Fly west.
Windom, Cottonwood County.—Hot; 98° in shade; millions go southwest; very high; occasionally one drops.
Butterfield, Watonwan County.—Light southwest wind; began to move with wind about 9.
Kanaranzie, Rock County.—Go west.
Vienna, Rock County.—A few alighted.
Magnolia, Rock County.—Go southwest same evening.

Bigelow, Nobles County.—Clear; very hot; wind southeast; turns east at noon; fly very thick west from 10.20 to 5; large swarms alight at 4 p. m.; *vid.* 8th.
Graham Lakes, Nobles County.—Large numbers go west; few came down.
Delafield, Jackson County.—At 1.30 p. m.; wind east; swarms increasing; go west.
Christiana, Dakota County.—Alighted; fly west; few alighted.
Tenhassen, Martin County.—Morning; wind southeast; very warm; upper fly west, lower northwest; very thick.
Yankton, Dakota.—Go north-northwest.
Tabor, Fremont County, Iowa.—Go north and northeast.

July 6.

Yellow Banks, Deuel County, Dakota.—Wind south and southeast; none.
Gary, Deuel County, Dakota.—Wind southeast; heavy; fly northwest; very high.
Medary, Brookings County, Dakota.—Wind south; fly north; large swarms.
Forestburg, Bramble County, Dakota.—Wind north (?); very warm; began to leave at 10; *vid.* 5th.
Rockport, Hanson County, Dakota.—Wind southeast; blowing hard; 97° in shade; fly from 10.30 to 5.
Audubon, Becker County.—Few lit from southeast; others passed northwest.
Herman, Grant County.—Alighted in vast numbers; *vid.* 7th.
Elbow Lake, Grant County.—Still fly north-northwest; considerable numbers alight in places.
Detroit, Becker County.—Fly north at 10 a. m.
Holmes City, Douglas County.—Go west; wind southeast.
Alexandria, Douglas County.—Fly northeast in clouds; few alighting.
Burnhamville, Todd County.—Some left south-southeast.
Round Prairie, Todd County.—Left in great numbers to southwest.
Long Prairie, Todd County.—Brisk southwest wind; fly with wind; some lit.
Morris, Stevens County.—Go northwest all day; all left in morning; more lit in p. m.; have been going west and northwest for past three days.
Westport, Pope County.—Go northwest; wind southeast, strong; not so numerous as before.
Saint Cloud, Stearns County.—Fly northwest in considerable numbers.
Saint Wendell, Stearns County.—Go west; nearly as many as on 5th.
Melrose, Stearns County.—Fly northwest with wind in large numbers.
Elk River, Sherburne County.—A few go north.
Becker, Sherburne County.—Strong southeast wind; arose about two miles east of here and flew about two hours to northwest.
Big Lake, Sherburne County.—Fly northwest; none alight.
Ortonville, Big Stone County.—Rose about noon and went west; strong wind.
Benson, Swift County.—Go northwest in great quantities.
Lac-qui-Parle, Lac-qui-Parle County.—Fly northwest; quantity decreasing.
Montevideo, Chippewa County.—Wind south; go north.
Willmar, Kandiyohi County.—Fly north in large quantities; northwest for last four days.
Lake Lillian, Kandiyohi County.—Fly northwest.
Dassel, Meeker County.—Fly west and south.
Litchfield, Meeker County.—Fly northwest about noon; large numbers.
Sweede Grove, Meeker County.—Fly north in small numbers.
Clearwater, Wright County.—Heavy flight to northwest; all that could fly are gone.
Corinna, Wright County.—Strong north wind; vast numbers left; go south.
Waverly, Martin County.—Rising and fly northwest.
Montrose, Wright County.—Fly northwest; few.
Granite Falls, Yellow Medicine County.—At noon air full; go west. All gone from here and none alighted yet.
Beaver Falls, Renville County.—Fly northwest.
Vicksburgh, Renville County.—None.
Brookfield.—South wind; swarms go northwest.
Hale, McLeod County.—Wind east; go west.
Severance, Sibley County.—Air full.
Tracy, Lyon County.—Fly northwest; none alighted.
Walnut Station, Redwood County.—Go northwest; heavy swarms.
Lamberton, Redwood County.—*Vid.* July 3; are now quite plenty in spots.
Cottonwood, Brown County.—Go northwest; very thick.
L. Prairie, Nicollet County.—Fly west.
Ridgeley, Dodge County, Nebraka.—Fly northwest.
Morristown, Rice County.—A few fly westerly till 11 a. m.
Ben Franklin, Murray County.—Wind southeast; flying.
Currier, Murray County.—Fly northwest.
Windom, Cottonwood County.—Few fly north.
Kanaranzie, Rock County.—Go northwest; *vid.* 7th.

Magnolia.—Go northwest; five hours passing.
Luverne, Rock County.—Good many fly north; some drop and some rise.
Bigelow, Nobles County.—Light southeast wind; fly northwest.
Adrian, Nobles County.—Light south wind; plenty fly.
Delafield, Jackson County.—Wind east of south; not so many fly; higher go west; lower northwest; a few stragglers alighted.
Tenhassen, Martin County.—Cloudy, and southeast wind; warm; some fly.
Sheldon.—Have been flying since 1st; not numerous to-day.
Sibley.—A few alighted at night; went on 7th.
Big Stone Lake.—Many fly northwest.
Luverne, Rock County.—Go northwest; wind southeast; five hours passing.
Tabor, Fremont County, Iowa.—Go north and northwest.
Yankton, Dakota.—Go north-northwest; wind south-southeast.
Nebo, Platte County, Nebraska.—Swarms leaving; go northwest; wind south.

July 7.

Fort Sisseton, Dakota.—Fly southeast; wind northeast; 15 miles per hour.
Sisseton Agency.—*Vide* letter.
Yellow Banks, Deuel County, Dakota.—North wind, light; warm; 'hoppers thick; some lit about 4; *vid.* 10th.
Gary, Deuel County, Dakota.—Fly south; a few lit; wind hauling from north to northwest.
Medary, Brookings County, Dakota.—Calm till 3; 'hoppers moving slowly; wind changes to northeast.
Dell Rapids, Minnehaha County, Dakota.—Great numbers go northwest; a large number came down in our vicinity; *vid.* 10th.
Forestburg, Bramble County, Dakota.—No wind and no 'hoppers till noon; then a heavy northeast wind carried large swarms southwest; none lit.
Rockport, Hansen County, Dakota.—Southeast wind; 98° in shade; wind southeast till 1 p. m., then changed to northwest; very few fly.
Detroit, Becker County.—As we go to press the air is thick with them flying from north.—[*Record.*
Herman, Grant County.—Arose at 11 and went west.
Elbow Lake, Grant County.—Fly in great numbers south-southeast; wind north.
Burnhamville, Todd County.—Some left to northwest.
Round Prairie, Todd County.—Left in great numbers; go west.
Long Prairie, Todd County.—North wind; warm and clear; go south thick.
Morris, Stevens County.—'Hoppers quiet till 10 o'clock, when they began to alight in showers, and kept it up till 5.30; coming from southeast.
Paynesville, Stearns County.—Few fly west.
Saint Wendall, Stearns County.—Go northwest; flight not so heavy nor course so well defined; many fly in circles very high.
Ortonville, Big Stone County.—Millions from north-northeast from 5 to 7 p. m.; dropped and ate savagely.
Benson, Swift County.—Wind changed to northeast; go west.
Lac qui Parle, Lac qui Parle County.—Wind north; go south in small quantities.
Baxter.—Wind north; go south in considerable numbers; gentle breeze.
Montevideo, Chippewa County.—Wind northwest; fly south; some fall.
Corinna, Wright County.—Quite a number left the fields, going a southerly course.
Vicksburg, Renville County.—Very hot; no wind; a few flying.
Severance, Sibley County.—Wind east in forenoon; go west.
Waconie, Carver County.—Fly over; but few alighted.
Harriston, Scott County.—None seen in air or on the ground.
Merriam.—All left; none seen flying.
Marshall, Lyon County.—None.
Walnut Station, Redwood County.—A few fly southeast.
Ridgeley, Nicollet County.—Few to be seen flying.
Le Sueur Centre, Le Sueur County.—Fly two points south of east; heavy flight.
Kasota, Le Sueur County.—More went northwest than any other direction; general statement.
Mountain Lake, Cottonwood County.—Almost all we have seen went north or northwest.
Windom, Cottonwood County.—None fly; wind little east of north.
Saint James, Watonwan County.—A few go north.
Madelia, Watonwan County.—A few go north.
Mankato, Blue Earth County.—Wind southwest; none fly.
Kanaranzie, Rock County.—Go north July 1 to 7; air full; as many come down as leave; alight in evening and leave in morning.
Magnolia.—Go northwest, alighting in west and north parts of the county.
Luverne, Rock County.—Good many fly north.

Worthington, Nobles County.—None flying.
Bigelow, Nobles County.—Wind southwest; a few fly with wind.
Adrian, Nobles County.—South wind; fly very thick; many lit.
Winnebago City, Faribault County.—Fly northeast.
Alden, Freeborn County.—First began to fly from our fields; wind northwest; medium; continue to fly from 11.30 to 2.30.
Haskins, Iowa.—For last seven days have been flying west or northwest in very large numbers. All ours have left, but others come in from southeast.
East Orange, Iowa.—Four days of this week they have been flying west and northwest in very large numbers; majority of those hatched here have gone with them.
Le Mars, Plymouth County, Iowa.—In the air for last few days; fly west.
Yankton, Dakota.—Go north-northwest; wind south-southeast.
Norwood, Carver County.—Go southeast; wind northwest.
Holmes City, Douglas County.—Fly from 10 to 2; wind northwest; weather warm and clear.
Luverne, Rock County.—Wind southeast; locusts flying northwest, alighting in the west and north part of the county.
Saint Paul, Ramsey County.—Fly northwest; some rising and some passing.

July 8.

Yellow Banks, Deuel County, Dakota.—Wind north; cool; a few in the afternoon.
Gary, Deuel County, Dakota.—Continued to fly south in great numbers; lower than before.
Medary, Brookings County, Dakota.—Light northwest wind; none observed.
Dell Rapids, Minnehaha County, Dakota.—Wind northeast; many fly.
Forestburg, Bramble County, Dakota.—Wind north; a few go south; very high.
Rockport, Hanson County, Dakota.—Wind southeast till noon, then northwest; none fly; 88° in shade.
Falls, Sioux County, Dakota.—None fly.
Township 136, *Range* 45, *Wilkin County.*—Wind south-southeast (?), moderate; fly high.
Clatterall, Otter Tail County.—Go southeast.
Saint Olaf, Otter Tail County.—Go south.
Herman, Grant County.—8th, 9th, and 10th, went south and southwest.
Elbow Lake, Grant County.—Fly southeast; wind northwest.
Osakis, Douglas County.—*Vid.* 10th.
Burnhamville, Todd County.—Some left for southeast.
Long Prairie, Todd County.—Wind northwest; warm and clear; fly southeast; high; moderate numbers.
Morris, Stevens County.—Go southeast all day; some left, but many alighted.
Saint Wendall, Stearns County.—Southeast; not so many.
Paynesville, Stearns County.—Go southeast, considerable numbers; many of ours joined them.
Clear Lake, Sherburne County.—Go southeast; few; wind northwest.
Becker, Sherburne County.—Go southeast, immense swarms; strong wind from north of west.
Ortonville, Big Stone County.—Left at noon; go southeast; swarms did not extend more than 10 miles west of here.
Benson, Swift County.—Go almost due south; not many as yet.
Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; none moving.
Baxter, Lac-qui-Parle County.—Wind northwest; good breeze; large numbers; go southeast.
Montevideo, Chippewa County.—Fly very thick southeast.
Lake Lillian, Kandiyohi County.—Fly southeast.
Corinna, Wright County.—Go south; quite thick.
Chatham, Wright County.—Large numbers alight; left at once; no damage
Brookfield, Renville County.—Few fly southeast.
Boon Lake, Renville County.—Wind northwest; go southeast all day.
Palmyra, Renville County.—Go southeast.
Vicksburg, Renville County.—Wind northwest; a few fly southeast.
Penn, McLeod County.—Go southeast; alighted very thick.
Glencoe, Dodge County, Nebraska.—Fly a little east of south for several days.
Hutchinson, McLeod County.—Fly a little east of south for several days.
Round Grove, Scott County, Iowa.—Fly southeast, thick; wind northwest.
New Auburn, Sibley County.—Go southeast in vast numbers.
Severance, Sibley County.—Go east; brisk west wind; clear.
Chanhassen, Carver County.—Fly in considerable numbers from a few degrees north of west, from 11 to 3.
Watertown, Carver County.—Fly south in large numbers.
Laketown, Carver County.—Fly high east-southeast.
Watonic, Carver County.—Alighted and left next day.

Hollywood, Carver County.—Alighted and left next day.
Young America, Carver County.—Fly southeast; seem to be coming down by millions.
Norwood, Carver County.—Fly southeast; thick.
Waconia, Carver County.—Fly over; but few alighted.
Shakopee, Scott County.—Fly southeast.
Farmington, Dakota County.—A small multitude fly over this way, east, at 1 p. m.; none lit.
Albin, Brown County.—Wind northwest; fly southeast.
New Ulm, Brown County.—Immense swarms go southeast at 2.30 p. m.
Lake Prairie, Nicollet County.—A few go southeast.
Ridgeley, Nicollet County.—Go southeast; immense swarms very high; none alighted.
Mankato, Blue Earth County.—Fly easterly; lit in Beauford, Daconia, and other eastern towns.
Wilton, Waseca County.—Fly very high southeast; moderate wind from northwest.
Kanaranzie, Rock County.—Large swarms fly southeast.
Vienna, Rock County.—In the air, and many rising.
Magnolia, Rock County.—Go southeast; large swarms; many leave.
Worthington, Nobles County.—Some flying.
Bigelow, Nobles County.—Clear; high northwest wind; fly southeast very thick from 11 to 5. Most of those that lit on the 5th and those that hatched here leave.
Adrian, Nobles County.—Wind north; most of them left by noon.
Delafield, Jackson County.—Wind northwest; fly southeast; small swarms; very few alighted.
Christiana, Jackson County.—Fly south, quite thick.
Lake Village, Brookings County, Dakota.—Few alighting; wind southeast.
Marshfield, Lincoln County.—Go northwest; wind southeast.
Big Stone Lake, Lincoln County.—Go northwest, many.
Excelsior, Hennepin County.—Flying from 11 to 3; wind northwest; none alighting.
Lawrence, Rock County.—Fly southeast; wind northwest; many leaving.

July 9.

Yellow Banks, Deuel County, Dakota.—Wind north; cool; thick from 11 to 3. A good many lit. *Vid.* 10th.
Gary, Deuel County, Dakota.—Fly south.
Medary, Brookings County, Dakota.—Wind northwest; a few fly southeast.
Forestburg, Bramble County, Dakota.—Same as 8th; cooler.
Rockport, Hanson County, Dakota.—Wind north; very few fly, and very high.
Fort Sisseton, Dakota.—Wind northwest; 20 miles per hour; fly southeast.
Clitherall, Otter Tail County.—Go southeast.
Saint Olaff, Otter Tail County.—Go south; immense swarms.
Herman, Grant County.—*Vid.* 8th.
Elbow Lake, Grant County.—Few fly southeast; wind northwest.
Osakis, Douglas County.—*Vid.* 10th.
Lake Prairie, Todd County.—Wind northwest; cool and clear; go southeast in moderate numbers.
Burnhamsville, Todd County.—Some left; go south.
Morris, Stevens County.—Go south all day; wind north; swarmed here about noon and many left.
Paynesville, Stearns County.—Go southeast two or three hours; tolerably numerous.
Saint Cloud, Stearns County.—Flying southwest for three days.
Saint Wendell, Stearns County.—Go southeast; few.
Clear Lake, Sherburne County.—Wind northwest; go southeast; few.
Big Lake, Sherburne County.—Fly southeast.
Ortonville, Big Stone County.—Northwest wind; in the air thick.
Benson, Swift County.—Go south; not very many.
Lac-qui-Parle, Lac-qui-parle County.—Wind northwest; fly southeast in large quantities.
Baxter, Lac-qui-parle County.—Fly southeast in large quantities.
Montevideo, Chippewa County.—High north wind; fly very thick.
Lake Lillian, Kandiyohi County.—Fly southeast.
Willmar, Kandiyohi County.—Fly southeast; wind northwest.
Dassel, Meeker County.—Fly southeast; none alight.
Corinna, Wright County.—Wind southeast (?); cloudy; none fly.
Vicksburg, Renville County.—Go southeast; wind northwest; cool.
Boon Lake, Renville County.—Go southeast; wind northwest.
Penn, McLeod County.—Fly southeast; thick.
Round Grove, McLeodCounty.—Fly southeast; thick; wind northwest.
Chauhassen, Carver County.—Wind few degrees north of west; numerous.
Laketown, Carver County.—Winds north; fly south.
Waconia, Carver County.—Fly over; few alighted.

Young America, Carver County.—Those that came on 8th left on 9th and 10th.
Farmington, Dakota County.—A few scattering ones go east.
LaPrairie, Nicollet County.—Vast numbers flying; quite a number alighted, doing considerable damage.
Ridgeley, Nicollet County.—Go southeast; immense swarms; very high; none alighted.
Saint Peter, Nicollet County.—Fly south.
Morristown, Rice County.—Going low; mostly east; not very numerous; none alighted.
Mankato, Blue Earth County.—Fly east.
Wilton, Waseca County.—Fly very high, southeast; moderate wind from northwest.
Kanaranzie, Rock County.—Go southeast.
Magnolia, Rock County.—Go southeast; some alighting and some leaving almost every day.
Worthington, Nobles County.—Wind northwest and north; fly as near southwest as possible.
Delafield, Jackson County.—Wind northwest; fly southeast; few; a few alighted.
Sibley County.—Fly southeast; wind northwest.
Swift County.—Fly southeast; wind northwest.
Scott County.—Fly southeast; wind northwest.
Luverne, Rock County.—Go southeast; wind northwest; a few alighting; weather warm.

July 10.

Yellow Banks, Deuel County, Dakota.—Wind north; cool in morning. 'Hoppers came about 10.30 a. m.; very thick, and a part of the time very low; lower course 150 feet high and extending upward as far as the eye could reach. Those here (*vid.* 7th and 8 h) left about 11 a. m., and about 12 m. as many more lit, but only about half as large as the others.
Gary, Deuel County, Dakota.—Fly southeast in great numbers; came down in swarms about 11 a. m.
Medary, Brookings County, Dakota.—North wind; a few fly; a few stragglers lit in spots.
Dell Rapids, Minnehaha County, Dakota.—North wind; great numbers fly south; many rose here and left.
Forestburg, Bramble County, Dakota.—North wind; cooler weather; those seen are very high.
Rockport, Hanson County, Dakota.—North wind; millions in the air; *Astoma gryllaria* seen; none lit.
Lake Village, Brookings County, Dakota.—Fly north; wind from south, 20 miles per hour.
Audubon, Becker County.—A few in the air from northwest.
Detroit, Becker County.—Air full from 10 to 3, but very few alight; wind northwest; millions go southeast.
Township 136, *range* 47, *Wilkin County.*—Wind moderate and steady; fly thick and high.
Saint Olaf, Otter Tail County.—Go south; immense swarms.
Clitherall, Otter Tail County.—Go southeast.
Elbow Lake, Grant County.—Fly southwest; wind northeast.
Osakis, Douglas County.—On 8th, 9th, and 10th favorable winds took vast numbers away.
Holmes City, Douglas County.—Very large swarms go southeast 11 till 12, then went south; good north wind.
Long Prairie, Todd County.—Wind north; cool and clear; fly south; moderate numbers.
Morris, Stevens County.—Wind north; go south; both low and high; from 10 to 3.
Paynesville, Stearns County.—Go nearly due south, great numbers; very high in afternoon; little west of south; none of our own left us.
Clear Lake, Sherburne County.—Go southeast; few; wind northwest.
Becker, Sherburne County.—Go due southeast; wind northwest; good breeze; two hours passing.
Big Lake, Sherburne County.—Go southeast.
Ortonville, Big Stone County.—Wind northwest; thick and high in air.
Benson, Swift County.—Go southwest in large numbers.
Lac-qui-parle, Lac-qui parle County.—Fly south and southwest; very thick; wind north.
Baxter, Lac-qui-parle County.—Go southeast in greater numbers than any day before by all odds; wind northwest, gentle.
Montevideo, Chippewa County.—High northwest wind; fly very thick; none alight.
Lake Lillian, Kandiyohi County.—Go southeast.
Manannah, Meeker County.—Left in great numbers; flew southwest.
Corinna, Wright County,—Go due south; more plenty than at any time yet.
Canby, Yellow Medicine County.—North wind; large swarms fly; most alighted.

Vicksburgh, Renville County.—Go south; wind northwest.
Boon Lake, Renville County.—Go south in swarms; wind north.
Penn, McLeod County.—Go southeast; thick from 11 to 4; most that we had left to-day.
Glencoe, McLeod County.—Go a little east of south: very thick.
Severance, Sibley County.—Go southeast, myriads; wind northwest; some alight.
Chanhassen, Carver County.—Fly from north-northwest; those that alighted on the 8th left, also others; many remain.
Lake Town, Carver County.—Few fly.
Benton, Carver County.—Commenced leaving.
Young America, Carver County.—Commenced leaving.
Marshall, Lyon County.—Go southeast. Lit from 3 miles west of here, to Gary, very thick.
Marshfield, Lincoln County.—Go southwest; heavy swarms.
Lamberton, Redwood County.—*Vide* July 6; then wind changed to north and northwest, and they came in thinly until the 10th; then heavy flights; many lit in spots in evening; many rise, and others drop every day.
Albin, Brown County.—Go south; wind north; alighting.
Bridgeley, Nicollet County.—Immense swarms go southeast; very high; none alight.
Saint Peter, Nicollet County.—Myriads move south; all around here joined, I think.
Kasota, Le Sueur County.—Go southwest; more fly than I ever saw at one time.
Le Sueur, Le Sueur County.—Go southwest: heavens black with them; air full, and we learn a number are alight on prairies adjacent to town.
Currie, Murray County.—Wind northwest; came down; left as soon as wind changed.
Westbrook, Cottonwood County.—Fly southeast; large swarms.
Mountain Lake, Cottonwood County.—Fly south in great numbers.
Windom, Cottonwood County.—Fly southwest.
Madelia, Watonwan County.—Wind northwest in morning; due north at noon; went south; and in afternoon went southwest; a few fell here.
Madelia, Cottonwood County.—Terribly thick; go south and southwest; in afternoon a few fall.
Mankato, Blue Earth County.—Wind northwest; heavy flight southeast, from an early hour to late in the evening; greater numbers than on any previous day; flew high; occasionally a disabled one dropped.
Waseca, Waseca County.—Fly southwest with wind.
Kanaranzie, Rock County.—Go southeast.
Vienna, Rock County.—Fly over.
Magnolia, Rock County.—Go southeast; some alight.
Worthington, Nobles County.—Fly southwest; wind northwest and north, mostly north; good many fly; none alight.
Delafield, Jackson County.—Wind nearly northwest; higher go southwest, lower southeast; largest swarm so far; quite a number alight.
Hunter, Jackson County.—Go south.
Christian, Jackson County.—Go south; alight in west and northwest part of the town.
Wells, Fairibault County.—Fly over; few alighted.
Freeborn, Freeborn County.—Light swarms go south; *vid.*, 11th.
Austin, Mower County.—Seen in small numbers; pass over city in southerly direction.
Pipe Stone, Pipe Stone County.—Flying at 10 a. m. southwest; wind north; high.
Saint Paul, Ramsey County.—Flying southeast.
Elk River, Ramsey County.—Flying southeast.
Big Stone Lake, Ramsey County.—Flying northwest.

July 11.

Lake Village, Brookings County, Dakota.—Fly north.
Cheyenne River Agency.—Fly west at 10 a. m.; weather warm and clear.
Walhalla, Pembina County, Dakota.—First seen; very few; high; go with wind from south to north.
Fargo, Pembina County, Dakota.—None seen.
Yellow Banks, Deuel County, Dakota.—South wind; pleasant; very few 'hoppers; hail and rain at night.
Gary, Deuel County, Dakota.—*Vid.* 10th, south wind; none seen flying; those here still remain; are destroying crops, vegetation, and grass.
Medary, Brookings County, Dakota—South wind; go northwest in large swarms.
Dell Rapids, Minnehaha County, Dakota.—South wind; many fly north.
Forestburg, Bramble County, Dakota.—Southeast wind; cool; fly high.
Rockport, Hanson County, Dakota.—Southeast wind; brisk; fly very high and thick; very few fall.
Sioux Falls, Minnehaha County, Dakota.—Few fly.
Moorhead, Clay County.—Small swarms fly northwest from 11 to 12.

Glyndon, Clay County.—Gentle wind from southeast; fly quite thick northwest; none lit.

Audubon, Becker County.—Fly northwest 10 to 4; the young join them; wind south, 15° east.

Detroit, Becker County.—Wind northwest; millions go southeast. (?)

Township 136, *Range* 45, *Wilkin County.*—Wind south; very unsteady; few fly, and those very high.

Clitherall, Otter Tail County.—Go north.

Herman, Grant County.—Wind southwest; fly northeast.

Elbow Lake, Grant County.—Fly northwest; wind southeast.

Alexandria, Douglas County.—Fly north.

Round Prairie, Todd County.—Arose and flew southwest.

Burnhamville, Todd County.—Passed northwest.

Paynesville, Stearns County.—Go north; thick, part of the time.

Albany, Stearns County.—Fly northwest in countless numbers.

Saint Wendall, Stearns County.—Go north; scarcely any fly.

Clear Lake, Sherburne County.—Go east; wind west; few.

Clear Lake, Sherburne County.—Fly in great numbers; none lit.

Big Lake, Sherburne County.—Fly southeast.

Ortonville, Big Stone County.—Go southeast in air thick and high.

Benson, Swift County.—Go nearly north; quite thick.

Kerkhoven, Swift County.—Quite a number fly northwest.

Lac-qui-parle, Lac-qui-parle County.—Wind southeast; fly northwest; few.

Baxter, Lac-qui-parle County.—Wind south; fly north.

Montevideo, Chippewa County.—High wind from northwest; (?) fly very thick; none lit.

Saint John's, Kandiyohi County.—In large numbers; flying before a high southwest wind.

Atwater, Meeker County.—Very few fly northwest.

Litchfield, Meeker County.—But few fly.

Corinna, Wright County.—Few fly southwest.

Waverly, Wright County.—Rise and go northwest.

Palmyra, Renville County.—Fly north.

Vicksburg, Renville County.—Fly north; wind southeast.

Boon Lake, Renville County.—Wind south; fly north, moderately.

Penn, McLeod County. County.—S rong south wind; none fly.

Glencoe, McLeod County.—Fly north; thick.

Laketown, Carver County.—None fly.

Carver, Carver County.—'Hoppers just hatching in meadows across the river.

Marshfield, Lincoln County.—Heavy swarms go northwest; wind south.

Tracy, Lyon County.—Go northwest; drop down thick.

Marshall, Lyon County.—Go northwest; many dropped all around.

Lamberton, Redwood County.—Wind southwest; few flew; main body seem to be 5 to 12 miles east and north of us.

Saint Peter, Nicollet County.—Wind south.

Le Sueur, Le Sueur County.—Fly southwest; have alighted this week on Ottawa Prairie and the opposite side of the river in somewhat alarming numbers; general course this week southeast, south, and southwest.

Currie, Murray County.—Fly north; very thick.

Westbrook, Cottonwood County.—Fly northwest; very large swarms.

Mount Lake, Cottonwood County.—Fly north; not so many as yesterday.

Windom, Cottonwood County.—Fly little west of north; natives leaving.

Madelia, Watonwan County.—Wind south; go northwest.

Kanaranzie, Rock County.—Go northwest.

Magnolia, Rock County.—Go northwest; large swarms.

Worthington, Nobles County.—Wind southeast; fly northwest; quite heavy; none lit.

Delafield, Jackson County.—Fly northwest; those that alighted on 10th leaving.

Hunter, Jackson County.—Fly northwest.

Freeborn, Freeborn County.—Wind changed to south; (*vid.* 10th); going north.

Sioux City, Iowa.—Passed over northwest, between here and Fort Randall.

Pipestone, Pipestone County.—Fly high to northwest at 10 a. m.; wind southeast.

Saint Paul, Ramsey County.—Fly southeast.

Moorhead, Clay County.—Fly northwest; wind southeast; few alighting.

Pope County.—Fly northwest.

Luverne, Rock County.—Fly northwest.

Chippewa County.—Flying.

July 12.

Yellow Banks, Deuel County, Dakota.—West wind; warm; a few 'hoppers.

Gary, Deuel County, Dakota.—South wind; heavy; still remain here.

Medary, Brookings County, Dakota.—South wind; strong; fly northwest.

Forestburg, Bramble County, Dakota.—South wind.
Rockport, Hanson County, Dakota.—Southeast wind; very high; none seen till 11 a. m., when a large cloud passed over; very few lit.
Lake Village, Brookings County, Dakota.—Go north; 20 miles per hour; wind south.
Glyndon, Clay County.—None seen.
Moorhead, Clay County.—Strong southeast wind; fly northwest; quite a number lit.
Detroit, Becker County.—Wind southeast; back again northwest.
Detroit, Becker County.—A few fly northwest.
Breckinridge, Wilkins County.—Large quantity fly northwest; good breeze; none lit.
Township 136, Range 45, Wilkins County.—Wind south; few fly (?).
Oscar Lake, Otter Tail County.—Alighting.
Clitherall, Otter Tail County.—Go north.
Elbow Lake, Grant County.—Fly northwest; wind southeast.
Alexandria, Douglas County.—Fly northwest in moderate numbers.
Round Prairie, Todd County.—Fly northwest; wind southeast.
Long Prairie, Todd County.—Southeast wind; partly clear; go northwest; moderate numbers.
Paynesville, Stearns County.—Fly north in small numbers.
Saint Wendall, Stearns County.—Fly northwest in great numbers; southeast wind; pretty strong; none lit.
Saint Cloud, Stearns County.—Fly northwest; large numbers; very high, with strong wind; none alighted.
Melrose, Stearns County—Very large numbers fly rapidly northwest, with strong wind; none lit.
Big Lake, Sherburne County—Fly northwest in small numbers; none lit.
Clear Lake, Sherburne County.—Fly west; immense numbers; none lit.
Ortonville, Big Stone County.—Wind southeast; none to be seen here.
Benson, Swift County—Go nearly north; not so many as before; wind high; a little cloudy; have nearly all left this vicinity.
Lac-qui-Parle, Lac qui-Parle County.—Fly northwest; few; wind southeast.
Baxter, Lac-qui-Parle County.—Fly north; very few; wind south.
Montevideo, Chippewa County.—Wind northwest [to northwest?]; coming back again, but not in such vast numbers.
Lake Lillian, Kandiyohi County.—Fly northwest; considerable numbers alighted.
Kandiyohi, Kandiyohi County.—Fly northwest in small numbers; weather dry and hot.
Willmar, Kandiyohi County—Fly northwest.
Swede Grove, Meeker County.—Wind southwest; none fly.
Litchfield, Meeker County.—Not many fly; go northwest; high southeast wind.
Dassel, Meeker County.—Large numbers fly northwest.
Smith Lake, Wright County.—None fly.
Corinna, Wright County.—Air seems alive; go northwest; strong southeast wind.
Delano, Wright County.—For past three or four days, air fairly alive.
Monticello, Wright County.—Have been rising and flying south every clear day this week.
Vicksburg, Renville County.—Wind southeast; fly northwest.
Boon Lake, Renville County.—Wind south; few seen.
Beaver Falls, Renville County.—Vast swarms continue to pass over this section, moving southeast, south-southwest, west-northwest.
Penn, McLeod County.—Strong south wind; none fly.
Glencoe, McLeod County.—Fly north; thick.
Severance, Sibley County.—Wind south.
Marshfield, Lincoln County.—None in sight of any account.
Marshall, Lyon County.—Fly southeast; dropped in northern part of county.
Redwood Falls, Redwood County.—Have been flying in immense numbers in different directions, according to wind; more or less swarms each day, but those dropped one day would start up the next.
Saint Peter, Nicollet County.—Fly northwest; but few; none lit.
Le Sueur, Le Sueur County.—Wind southwest; none fly.
Morristown, Rice County.—Wind northwest; 80°; at noon fly very high; most went over.
Westbrook, Cottonwood County.—Fly north.
Mount Lake, Cottonwood County.—Fly north; few.
Madelia, Watonwan County.—Go northwest; wind south.
Kanaranzie, Rock County.—Go north; a very few alight.
Magnolia, Rock County.—Go northwest.
Worthington, Nobles County.—Strong southeast wind; fly northwest; heavy.
Delafield, Jackson County.—Few in air; go northwest.
Omaha, Douglas County, Nebraska.—Fly north.
Plattsmouth, Cass County, Nebraska.—Fly north 20° west.

July 13.

Yellow Banks, Deuel County, Dakota.—Southeast wind; thick from 11 to 2; those that lit on the 10th left about noon; and about 2 o'clock twice their number lit; at 6 p. m. high wind and rain.

Gary, Deuel County, Dakota.—*Vid.* 10th; still remain; wind south.

Medary, Brookings County, Dakota.—Wind changeable; cloudy; some rain.

Forestburg, Bramble County, Dakota.—None seen; not much wind.

Rockport, Hanson County, Dakota.—North wind; 'hoppers very lively; wind changed to southeast at 4 p. m.; none lit.

Traill, Caledonia County, Dakota.—No signs of any in this county yet; none hatched here.

Glyndon, Clay County.—None seen,

Detroit, Becker County.—Cloudy, with rain.

Elbow Lake, Grant County.—Fly in great numbers northeast from 12 to 2; wind southwest; alighted all over the county; nearly all left on 14th; no damage.

Long Prairie, Todd County.—Wind west-southwest; partly clear; go east-southeast; moderate numbers.

Saint Wendall, Stearns County.—Cloudy; none fly.

Ortonville, Big Stone County.—Heavy rain and hail last night; in morning very warm; slight wind; very few in air; go southeast.

Benson, Swift County.—Fly east in small quantities.

Lac-qui-Parle, Lac-qui-Parle County.—Fly northwest; few; wind southeast.

Baxter, Lac-qui-Parle County.—Wind south; none fly.

Monticello, Chippewa County —*Vid.* 12th.

Corinna, Wright County.—None fly.

McLean Township, Ramsey County.—Quite large numbers flew over at 6 a. m.; fly low; go northeast; none alight.

Boon Lake, Renville County.—Wind southeast; fly northwest.

Hector, Renville County.—Wind south; fly with wind.

Severance, Sibley County.—Wind south; cloudy.

Marshfield, Lincoln County.—None in sight of any account.

Marshall, Lyon County.—None in sight of any account.

Westbrook, Cottonwood County.—Cloudy; none seen.

Mount Lake, Cottonwood County.—Fly north; few.

Kanaranzie, Rock County —Very few fly.

Magnolia, Rock County.—Go northwest.

Worthington, Nobles County.—Wind varying from southeast, south, and southwest; rain in morning; none fly.

Middleton, Jackson County.—Took flight from here to northwest.

None flying on Sioux City and Saint Paul or main and branch lines of Saint Paul and Pacific Railroad.—[Saint Paul Dispatch.

Plattsmouth, Cass County, Nebraska.—Fly north 20° west.

Luverne, Rock County.—Fly northwest; wind southeast.

July 14.

Walhalla, Pembina County, Dakota.—Flying from 9 to 11 a. m.; wind south; few lit.

Yellow Banks, Deuel County, Dakota.—Wind south; warm and clear; no 'hoppers.

Gary, Deuel County, Dakota.—Wind southeast; began to leave (*vid.* 10th) about 10; at 1 p. m. all are gone to northwest. This swarm extended only 3 miles south of here.

Medary, Brookings County, Dakota.—Strong south wind; immense swarms move northwest; a few lit.

Dell Rapids, Minnehaha County, Dakota.—Strong south wind; many lit late in afternoon.

Forestburg, Bramble County, Dakota.—Strong south wind; going north.

Rockport, Hanson County, Dakota.—Strong south wind; plenty flying very high.

Fargo, Cass County, Dakota.—Commenced flying at 10; gentle southeast wind in morning; at noon air full; fly northwest; afternoon wind changed to northeast; air full; fly southwest; flew low all day; none alight.

Moorhead, Clay County.—Fly northwest, very thick; wind southeast; quite a number alighted, *vid.* 16th.

Detroit, Becker County.—Wind southeast; go northwest.

Township 136, *Range* 45, *Wilkins County.*—Wind southeast; 'hoppers very thick; go northwest; a good many rising; some alight.

Elbow Lake, Grant County.—Fly northwest; wind southeast; plenty of them; *vid* 13th.

Burnhamville, Todd County.—Moved north; nearly all the hatch gone.

Long Prairie, Todd County.—South-southeast wind; warm and clear; go north-northwest; thick.

Saint Wendall, Stearns County.—Fly northwest in great numbers; some alight, more leave; saw two copulating.

Benson, Swift County.—Fly north in great quantities.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; fly northwest; few.
Baxter, Lac-qui-Parle County.—Wind south; fly north; small number.
Montevideo, Chippewa County.—*Vid.* 12th.
Canley, Yellow Medicine County.—*Vid.* 10th; main body left at 12 m; fly north.
Hector, Renville County.—Wind southeast; fly with wind.
Benton, Carver County.—Fly northwest; small numbers.
Marshfield, Lincoln County.—None in sight of any account.
Marshall, Lyon County.—None.
Ceresco, Redwood County.—Fly northwest; alighting.
Albin, Brown County.—Fly northwest; wind southeast.
Douglas, Rice County.—A few have appeared in a field near town, not enough to do damage; occasionally can be seen in small squads flying southeast.
Mountain Lake, Cottonwood County.—Fly north; few.
Kanaranzie, Rock County.—Fly north.
Magnolia, Rock County.—Fly northwest.
Worthington, Nobles County.—Heavy rain last night; wind settled to southeast, and many flew northwest.
Luverne, Rock County.—Fly northwest; wind southeast.

July 15.

Yellow Banks, Deuel County, Dakota.—Wind south; warm and clear; no 'hoppers.
Gary, Deuel County, Dakota.—Wind southwest; fly northeast.
Medary, Brookings County, Dakota.—Wind northwest; some carried southeast; so far winds from south carry immense swarms; winds from north carry over but few.
Forestburg, Bramble County, Dakota.—Flying low and thick; none lit.
Rockport, Hanson County, Dakota.—Wind northwest; very cloudy; not easy to see them, but some are moving.
Detroit, Becker County.—None fly.
Scambler, Otter Tail County.—Fly east.
Elbow Lake, Grant County.—Fly south-southeast; wind from northwest; very few.
Long Prairie, Todd County.—Wind west-northwest; cool and clear; go south-southeast; moderate numbers.
Saint Wendell, Stearns County.—Go southeast in great numbers; many dropped.
Benson, Swift County.—Fly southerly in small numbers.
Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; flew southeast about one hour.
Baxter, Lac-qui-Parle County.—Wind strong, northwest; flew southeast; few.
Montevideo, Chippewa County.—None to be seen.
Hector, Renville County.—Heavy rain.
Young America, Carver County.—Large numbers came down.
Benton, Carver County.—Fly southeast in large numbers; large numbers dropping in this town.
Marshall, Lyon County.—Fly southeast; some alighted.
Albin, Brown County.—Fly south-southeast; wind north-northwest; large swarms leaving here.
Mountain Lake, Cottonwood County.—Wind from north, strong; vast numbers fly south; began to fly south this day, and continued to do so till 2 o'clock.
Butterfield, Watonwan County.—Go southwest with strong wind in great quantities; many light and remain till 20th; *vid.* 20th.
Kanaranzie, Rock County.—Fly southeast.
Magnolia, Rock County.—Fly southeast; wind northwest; almost all gone from here.
Worthington, Nobles County.—Wind northwest; quite a number fly as near south as possible.
Hunter, Jackson County.—Fly south.
Nashville, Martin County.—Wind northwest; came on us in great abundance; staid till 19th.
Tenhassen, Martin County.—First alighted here; staid a few hours and then left.
Glencoe, Dodge County, Nebraska.—Fly southwest in abundance; some alighting.
Dassel, Meeker County.—Fly southwest from 11th to 12th; wind east.
Luverne, Rock County.—Fly southeast; wind northwest.

July 16.

Cheyenne River Agency.—Fly east at 11 a. m.; wind west; returning swarms quite dense.
Yellow Banks, Deuel County, Dakota.—Wind north; warm; a few 'hoppers.
Gary, Deuel County, Dakota.—Fly east with wind; very high.
Medary, Brookings County, Dakota.—Wind northwest; light; none.
Forestburg, Bramble County, Dakota.—No wind; cool; fly in every direction; plenty in the air.
Rockport, Hanson County, Dakota.—Light northwest wind; at 3 p. m. wind southwest; 'hoppers still in the air till 6 p. m.

Crookstone, Polk County.—Fly north; few.
Moorhead, Clay County.—Many of those that alighted on the 14th left; going northeast.
Detroit, Becker County.—Wind west; a few go east; large numbers here yet.
Scambler, Otter Tail County.—Fly east.
Elbow Lake, Grant County.—A few fly southeast.
Long Prairie, Todd County.—Wind west; warm and clear; go east; moderate numbers.
Saint Wendell, Stearns County.—Few flying; some alight.
Benson, Swift County.—Wind northwest; small numbers fly southeast.
Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; flew southeast; few.
Baxter, Lac-qui-Parle County.—Wind northwest; stiff breeze; flew southeast, low; very few.
Montevideo, Chippewa County.—*Vid.* 15th.
Willmar, Kandiyohi County.—A few go southeast.
Hector, Renville County.—Wind northwest; a few fly.
Severance, Sibley County.—Warm and clear; plenty fly.
Marshall, Lyon County.—West wind; few fly east.
Albin, Brown County.—But few left; wind north-northwest.
Le Sueur Centre, Le Sueur County.—Heavy flight in easterly direction; many drop during the day.
Morristown, Rice County.—Clear; northwest wind; fly southeast in considerable numbers.
Waseca, Waseca County.—Fly over to southeast.
Kanaranzie, Rock County.—Fly east; very few alight.
Worthington, Nobles County.—Brisk west wind; very few fly about noon.

July 17.

Yellow Banks, Deuel County, Dakota.—North wind; warm; a few 'hoppers.
Gary, Deuel County, Dakota.—Fly southeast in millions; some lit about 9 a. m.
Medary, Brookings County, Dakota.—Cloudy part of the day; none.
Dell Rapids, Minnehaha County.—Wind northwest; many flying; some lit.
Forestburg, Bramble County.—Wind northwest; quite cold; cloudy; none seen.
Rockport, Hanson County, Dakota.—Wind north; light to 12 m.; after that a strong breeze carried many over.
Crookstone, Polk County.—Fly north; few.
Detroit, Becker County.—Cloudy, cool, and damp; none move.
Township 136, *Range* 45, *Wilkin County.*—Wind northwest; blowing hard; at 10 a. m. 'hoppers were alighting; at 12 m. began to rise; nearly all rose and went southeast.
Scambler, Otter Tail County.—Fly east.
Elbow Lake, Grant County.—A few fly southeast; wind northwest.
Long Prairie, Todd County.—Wind west; warm and clear; go east, thick.
Burnhamsville, Todd County.—Extensive swarms go east-southeast.
Saint Wendell, Stearns County.—Fly sparingly.
Benson, Swift County.—Fly south, quite thick.
Baxter, Lac-qui-Parle County.—Wind northwest; few fly southeast.
Montevideo, Chippewa County.—17th, 18th, and 19th very cold; none to be seen.
Willmar, Kandiyohi County.—A few go southeast.
Hector, Renville County.—Wind northwest; a few fly.
Severance, Sibley County.—Warm and clear; plenty fly.
Benton, Carver County.—Dark day; none fly.
Marshall, Lyon County.—Wind west; fly east; many dropped in this vicinity.
Le Sueur Centre, Le Sueur County.—Go southeast, very thick.
Waterville, Le Sueur County.—Settled down on about two sections lying east of town.
Morristown, Rice County.—Fly southeast; none alight, but many rising.
Waseca, Waseca County.—Fly north; large numbers.
Kanaranzie, Rock County.—Only a few fly south and southeast.
Worthington, Nobles County.—Wind west to northwest; scarcely any fly.

July 18.

Worthington, Barnes County, Dakota.—Wind blowing from northwest for three days; a few brought.
Yellow Banks, Deuel County, Dakota.—Wind north; cloudy; quite cool; no 'hoppers.
Gary, Deuel County, Dakota.—Wind northwest; fly southeast; cloudy.
Medary, Brookings County, Dakota.—Wind northwest; cloudy and cold; occasional mists of rain.
Forestburg, Bramble County, Dakota.—Wind northwest; cloudy; quite cold; none seen.
Rockport, Hanson County, Dakota.—Wind northwest; cool and cloudy; none seen.
Audubon, Becker County.—Cold; none moving.
Detroit, Becker County.—Cloudy, cold, and damp; none moving.
Elbow Lake, Grant County.—Wind northwest; none flying.

Saint Wendell, Stearns County.—Wind northwest, strong; none flying; cool.
Benson, Swift County.—Cold and cloudy; no 'hoppers.
Benton, Carver County.—Dark day; none flying.
Marshall, Lyon County.—Wind northwest; cold and cloudy; none fly.
Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; cloudy; none flying.
Baxter, Lac-qui-Parle County.—Wind northwest, strong; cloudy and cold; no 'hoppers.
Montevideo, Chippewa County.—Very cold; none to be seen.
Hector, Renville County.—Wind northwest; cold and cloudy; none seen.
Morristown, Rice County.—Wind northwest; cloudy and cool; fly east.
Kanaranzie, Rock County.—Only a few fly south and southeast.
Worthington, Nobles County.—Wind northwest; cloudy and cool; none fly.
Glencoe, Dodge County, Nebraska.—Fly southwest in abundance; some alighting.
Lincoln Lancaster County, Nebraska.—Fly east of south.
Norton Norton County, Kansas.—Wind northeast; fly south.

July 19.

Walhalla, Pembina County, Dakota.—Wind north; pretty strong; clear; fly south; not in great numbers.
Yellow Banks, Deuel County, Dakota.—Wind north; quite cold; a good many lit about 4 p. m. *Vid.* 20th.
Medary, Brookings County, Dakota.—Same as 18th; wind northwest; cloudy and cold; occasional mists of rain.
Forestburg, Bramble County, Dakota.—Wind northwest; quite cold; cloudy; none seen.
Rockport, Hanson County, Dakota.—Wind northwest; cool; cloudy; none seen.
Moorhead, Clay County.—Nearly all the balance (*vid.* 16th); left to-day; go south.
Audubon, Becker County.—Cold; none moving until p. m.
Detroit, Becker County.—Cold, damp, and cloudy; none moving.
Township 136, *Range* 45, *Wilkin County.*—Wind northwest; 'hoppers flying; some rise; some alight.
Elbow Lake, Grant County.—Wind northwest; a few fly southeast.
Saint Wendell, Stearns County.—Wind northwest; cloudy; cool; many rose and went south.
Benson, Swift County.—Fly south in afternoon; not very thick.
Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; cloudy; none fly.
Baxter, Lac-qui-Parle County.—Cold and cloudy; very few fly southeast.
Montevideo, Chippewa County.—Very cold; none to be seen.
Hector, Renville County.—Wind northwest; cold and cloudy.
Beaver Falls, Renville County.—Great majority seem to have departed.
Benton, Carver County.—Dark day; none fly.
Carver, Carver County.—Large swarms; fly in a south or southwest direction.
Marshall, Lyon County.—Wind northwest; cold; fly southeast in afternoon.
Redwood Falls, Redwood County.—Last week they lit in all parts of the county, and staid a few days, doing some damage; all now gone.—[*Gazette.*
Kanaranzie, Rock County.—Only a few fly south and southeast.
Worthington, Nobles County.—Wind northwest; cloudy and cool; none fly.
Dakota, Dakota County, Nebraska.—Fly south.

July 20.

Walhalla, Pembina County, Dakota.—Light northwest; sunshine; fly southeast; not numerous.
Caledonia, Traill County, Dakota.—North wind for five days past; good many go south; none have passed from south this season.
Yellow Banks, Deuel County, Dakota.—Light northwest; warm; a frightful swarm came about 9 a. m. Those that were here joined the flight at once, making a dense swarm from about 40 feet high to as high as the eye could reach. By 11 a. m. the lower ones were from 150 to 200 feet high; continued much the same to 3 p. m.; none alighted.
Gary, Deuel County, Dakota.—Strong wind; fly south in great numbers very high.
Medary, Brookings County, Dakota.—North wind; clear; immense swarms go south all day. The few scattered on the prairie rise and leave.
Dell Rapids, Minnehaha County, Dakota.—Wind northeast; great many go southwest.
Forestburg, Bramble County, Dakota.—Wind northwest; fly south.
Rockport, Hanson County, Dakota.—Wind northwest; began to fly at 1 p. m.; very thick; none lit.
Sioux Falls, Minnehaha County, Dakota.—Fly south; few alighted as yet. The greatest quantity of 'hoppers that has yet been seen passed over southeast. A few came down about six miles south of here, but did no damage.
Moorhead, Clay County.—Fly south and southeast, very thick.
Audubon, Becker County.—Wind north 10° west; air full; highest I ever saw; stragglers alight.

Detroit, Becker County.—Wind northwest; very pleasant; began to fly at 10 a. m., and all we had here left us; an immense quantity passed.

Township 136, Range 45, Wilkin County.—Wind northwest, very unsteady; 'hoppers fly over; our batch that are large enough rise most when the wind comes in gusts.

Fergus Falls, Otter Tail County.—Commenced flight to southward.

Elbow Lake, Grant County.—Fly southeast; wind northwest more than at any time this season.

Long Prairie, Todd County.—North wind; cool and clear; go south, thick.

Saint Wendell, Stearns County.—Wind nearly north; great numbers fly nearly south; some come down.

Saint Cloud, Stearns County.—Fly south in great numbers; a few alight.

Becker, Sherburne County.—The last left here; go southwest; good breeze from northwest.

Benson, Swift County.—Fly west of south in great numbers; few alight.

De Graff, Swift County.—Fly east; none alight.

Lac-qui-Parle, Lac-qui-Parle County.—Fly south-southeast, thick; wind northwest.

Baxter, Lac-qui-Parle County.—Wind northwest; clear and warm; vast numbers fly very high, southeast.

Montevideo, Chippewa County.—Wind northwest; no 'hoppers scarcely.

Kandiyohi, Kandiyohi County.—Good many fly southeast; only a few drop.

Willmar, Kandiyohi County.—Lots fly southeast.

Manannah, Meeker County.—The remainder (*vid.* 10th) flew northwest (?); but few are left.

Palmyra, Renville County.—Passed over southerly; none seen for two weeks past.

Hector, Renville County.—Wind northwest.

Glencoe, McLeod County.—Fly very thick, southeast.

Penn, McLeod County.—A few scattering go south.

Benton, Carver County.—Great numbers fly southwest; wind from north.

Carver, Carver County.—Large swarms fly in southerly or southwesterly direction; some alight near town.

Shakopee, Scott County.—Wind northwest to north; clear; fly in great numbers southeast to south from 10 to 3 o'clock.

Marshfield, Lincoln County.—Wind north; immense swarms came in sight about 11 o'clock, flying south till sundown.

Marshall, Lyon County.—Pleasant; air full; go southeast all day.

Lamberton, Redwood County.—Wind from north and northwest; 8th to 20th flight has been steady, and culminated in a grand rush on the 20th; the heaviest flight I ever saw.

Albion, Brown County.—Few flying; wind north-northwest; no coupling or laying yet.

Saint Peter, Nicollet County.—Very thick; most of them very high; all go southeast.

LeSueur, LeSueur County.—Passed over to south in greater numbers than at any previous time; were at a great height, and the sun was almost obscured by the immense mass.

LeSueur Centre, LeSueur County.—Heavy flight to south; some few dropped near night on some farms.

Waterville, LeSueur County.—All left from all around here and went south; none lit.

Morristown, Rice County.—Fly little west of south more than ever before.

Morristown, Rice County.—Went east in large numbers; most of those hatched here went with them.

Pipestone, Pipestone County.—Wind north; fly thick.

Windom, Cottonwood County.—Fly south.

Mount Lake, Cottonwood County.—The last passed south 2 30 p. m.

Madelia, Watonwan County.—Fly south; wind northwest.

Butterfield, Watonwan County.—From 15th to 20th wind west and northwest; to-day changed to north and nearly all left; go south.

Saint James, Watonwan County.—All left here to-day.

Mankato, Blue Earth County.—Millions fly high at 11 a. m.; go south.

Wilton, Waseca County.—Large numbers fly south; very few have alighted here.

Waseca, Waseca County.—The 'hoppers in this section arose and flew to south-southwest.

Lucerne, Rock County.—Immense swarms go south, not alighting except rarely; at 12:30 p. m., fell in small numbers in places to south and east. Upper region filled with 'hoppers; fly southward.

Magnolia, Rock County.—Large swarms fly south, southwest, and southeast, varying with wind. Many alight in south part of county.

Kanaranzie, Rock County.—Fly south; largest swarm seen yet; none alighted.

Little Rock, Noble County.—Immense swarms go south; a few cripples fall.

Adrian, Nobles County.—Wind north; fly very high and thick.

Worthington, Nobles County.—Flying in clouds; few come down in this vicinity. Wind north, tending east; quite a good many fly as near west as wind will allow.

Bigelow, Nobles County.—Wind north; clear; large swarms flew south.

Brownsburg, Jackson County.—Immense numbers go south; wind from north.

Jackson, Jackson County.—Are flying nine miles deep as we go to press.—[*Republic.*

Hunter, Jackson County.—Go south; most numerous I have seen this year.

Blue Earth City, Faribault County.—Clouds fly over south; only a few stopped in this vicinity.

Winnebago City, Faribault County.—Air full from 9 a. m. to 6 p. m.; fly southeast. Began to fly at 9.30 a little east of south with good breeze; dense numbers as high as the eye could see; flew till 3.—[*Pioneer Press.*

Alighted quite thick.—[*Dispatch.*

Alden, Freeborn County.—Left here, and the air was full; thicker than I ever saw before; flying from 11 a. m. to 3 p. m.; wind north-northeast; some commence to couple.

Freeborn, Freeborn County.—Began to fly at 11 a. m.; go southeast to south; air full till 4; some alight; none left us.

Albert Lea, Freeborn County.—Fly south at 11 a. m.; strong north wind.

Geneva, Freeborn County.—First flight; left here in large numbers; go southeast.

Algona, Kossuth County, Iowa.—A large number are said to have alighted around Algona.

Carroll City, Freeborn County, Iowa.—Large swarm flew over to southeast for two hours.

Dakota City, Humboldt County, Iowa.—Weather clear; wind northwest; 'hoppers fly southeast in afternoon, some alighting.

Lake Village, Brookings County, Dakota.—Wind north; cloudy; small swarms.

Banks, Faribault County, Dakota.—Fly southwest; wind northeast.

July 21.

Bismarck, Burleigh County, Dakota.—Flying high to northwest; wind southeast; occasionally one dropping.

Dakota, Dakota County, Nebraska.—At 2 o'clock flying south; low and north three-fourths mile higher.

Yellow Banks, Deuel County, Dakota.—South wind; none.

Gary, Deuel County, Dakota.—Fly northeast; none lit.

Medary, Brookings County, Dakota.—Light south wind; a few flying.

Forestburg, Bramble County, Dakota.—Plenty going north.

Rockport, Hanson County, Dakota.—Very light south wind; flying very low at 9; at 12 m., falling like hail; many have stopped, but do not seem to eat.

Sioux Falls, Minnehaha County, Dakota.—Those that lit on 20th rose to-day and went northeast.

Fargo, Minnehaha County, Dakota.—A great many are flying from southeast (?)—[*Pioneer Press.*

Glyndon, Clay County.—A few came down with a south wind: left next afternoon; scarcely any flying to-day.

Detroit, Becker County.—No air stirring; none moving.

Perham, Otter Tail County.—For three or four days have been flying southeast; to-day wind southwest; none moving.

Fergus Falls, Otter Tail County.—A flight to the south generally cleared us of what had not already fled or died.

Herman, Grant County.—A few fly southeast; none alight.

Chippewa, Douglas County.—Are leaving; go south or southeast; seem diseased; many dead.

Long Prairie, Todd County.—Wind southwest; warm and clear; go northeast; moderate numbers.

Morris, Stevens County.—Go north; wind south.

Hancock, Stevens County.—Fly southeast.—[*Pioneer Press.* Few to be seen.—[*Dispatch.*

Saint Cloud, Stearns County.—Fly south in small numbers; none alight.

Saint Wendell, Stearns County.—Clear northwest wind; but very few fly.

Big Lake, Sherburne County.—A few fly southeast; none alight.

Clear Lake, Sherburne County.—Small numbers fly southeast; none alight.

Benson, Swift County.—Fly west of south in small quantities.

De Graff, Swift County.—Few in the air to-day.

Lac-qui-Parle, Lac-qui-Parle County.—21st to 26th, wind southeast; no 'hoppers in any great quantity.

Baxter, Lac-qui-Parle County.—Wind northwest; very light, clear, and warm; very few fly southeast.

Montevideo, Chippewa County.—Wind northwest; no 'hoppers scarcely.

Saint John's, Kandiyohi County.—Fly south in very small numbers for a few hours.

Willmar, Kandiyohi County.—A few circling round in air; don't appear to go in any particular direction.

Kandiyohi, Kandiyohi County.—Very few fly.
Litchfield, Meeker County.—Very few fly; seem to work south; progress slow.
Dassell, Meeker County.—A few fly southeast to-day.
Swede Grove, Meeker County.—A few fly southeast this morning; none alight.
Albany, Wright County.—Very few southeast.
Albion, Wright County.—For a number of days air full; fly over; very few alight, and those left the next day.
Hector, Renville County.—'Hoppers very thick.
Benton, Carver County.—Few fly southwest; very little damage done here.
Marshfield, Lincoln County.—Wind south in morning; west in afternoon; none fly.
Marshall, Lyon County.—Pleasant; fly southeast in morning; east to northeast in afternoon.
Saint Peter, Nicollet County.—Fly south about noon; but few alight; not enough to do any damage.
Morristown, Rice County.—8 a. m., air very still; flying higher; lower, go south; 12 m., wind northeast; clear; very few fly.
Pipestone, Pipestone County.—Fly thick; wind south.
Windom, Cottonwood County.—None fly.
Madelia, Watonwan County.—Go south; wind northwest; have all left here; the latest hatch have got wings and gone.
Mankato, Blue Earth County.—Air filled all day at a great height with immense numbers; go slightly west of south; wind pretty strong.
Lake Crystal, Blue Earth County.—A few fly south this morning; none alight.
Waseca, Waseca County.—Arose and flew to south southwest.
Kanaranzie, Rock County.—Very few fly to northeast.
Luverne, Rock County.—Fly southeast; few alighting.
Magnolia, Rock County.—Many in air; no wind; some go north, some south.
Bigelow, Nobles County.—Clear; north wind; large swarms flew south.
Adrian, Nobles County.—Wind south; none.
Worthington, Nobles County.—Wind south-southeast; very light; quite a good many fly high, to northwest.
Brownsburg, Jackson County.—Immense numbers go south; wind from north.
Delafield, Jackson County.—Flying very irregularly since last report; few flying to-day.
Lake Village, Brookings County, Dakota.—Go north.

July 22.

Bismarck, Burleigh County, Dakota.—Flying with the wind from southeast to northwest; did not alight.
Yellow Banks, Deuel County, Dakota.—Wind south; no 'hoppers.
Gary, Deuel County, Dakota.—Fly northwest from 9 a. m. to 6 p. m.; none came down; wind south for five days, to 27th.
Medary, Brookings County.—Wind south; some large swarms move northwest; some lit west and northwest of here.
Dell Rapids, Minnehaha County.—Southwest; some fly north.
Forestburg, Bramble County, Dakota.—Plenty going north.
Rockport, Hanson County, Dakota.—Very brisk southeast wind; 'hoppers in the air; at 12 m. began to leave here, but more lit in the evening.
Dog's-Foot Station.—Are very thick here, and are still coming from southeast in large numbers.
N. B.—No one can tell us where Dog's-Foot Station is; it may be Dog's-Tooth Station, about 30 miles west of Bismarck, on the way to the Black Hills.
Moorhead, Clay County.—Fly northwest; very numerous nearly all day.
Audubon, Becker County.—Fly in great numbers from about noon to 4 p. m., from south 15° east to north 15° west; some fall, but not enough to do damage.
Detroit, Becker County.—Wind southeast; fly back northwest; good many light toward evening.
Fergus Falls, Otter Tail County.—Wind south; clear; none fly.
Brown's Valley, Traverse County.—A few go north; most of the swarms that have passed here have gone from northwest to southeast.
Long Prarie, Todd County.—Wind south; warm and clear; go north; moderate numbers.
Morris, Stevens County.—Still go north; fly very high, but very few.
Saint Wendell, Stearns County.—Clear; wind west; but very few fly; all gone from here.
Benson, Swift County.—Fly north; not very many.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; no 'hoppers in any great quantity.
Baxter, Lac-qui-Parle County.—Wind south; clear; hot; good breeze; but few flying southeast. (?)

Montevideo, Chippewa County.—Wind northwest; no 'hoppers scarcely.
Hector, Renville County.—Wind southeast.
Marshall, Lyon County.—Wind south; many fly north.
Morristown, Rice County,—Very few go nearly west.
Pipe Stone, Pipe Stone County.—Wind south; flying thick.
Magnolia, Rock County.—Go northwest.
Kanaranzie, Rock County.—A few fly north.
Worthington, Nobles County.—Wind southeast; good breeze all day; heavy flight to northwest; high.
Adrian, Nobles County.—Wind south; none.
Delafield, Jackson County.—Great swarms go southwest; first seen at 2.30 p. m.; very high.
Hunter, Jackson County.—Go north.
Dakota, Dakota County, Nebraska.—Go northwest.
Plattsmouth, Cass County, Nebraska.—Fly north from 12 m. to 7 p. m.; wind south; one-quarter mile deep.

July 23.

Bismarck, Burleigh County, Dakota.—Alighted in considerable numbers in the morning very early.
Yellow Banks, Deuel County, Dakota.—Wind south; none.
Medary, Brookings County, Dakota.—Wind south; none observed.
Forestburg, Bramble County, Dakota.—Wind south; clear and pleasant; light swarms go north.
Rockport, Hanson County, Dakota.—Wind southeast; very high; in the air at noon; many have stopped.
Crookston, Polk County.—A few fly lazily north: fresh south winds.
Moorhead, Clay County.—Few fly south (?).
Audubon, Becker County.—Wind south, but none fly at 10 a. m.
Detroit, Becker County—Wind south, strong; moving; good many here, but eat nothing yet.
Fergus Falls, Otter Tail County.—Wind south; clear; none fly.
Morris, Stevens County.—Still go north; very few; wind south.
Benson, Swift County.—Fly north; very few; still a few here, but cannot see them eating or depositing eggs.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; no 'hoppers in any great quantity.
Baxter, Lac-qui-Parle County.—Wind south, strong; clear and warm; none fly.
Montevideo, Chippewa County.—Wind southeast; but few fly; none lit; all have left us.
Hector, Renville County.—Wind south; none.
Marshfield, Lincoln County.—Wind south; very few fly; have but two reports of their beginning to couple.
Kanaranzie, Rock County.—A few fly north.
Adrian, Nobles County.—Wind south; none.
Worthington, Nobles County.—Wind strong, south-southeast; heavy flight from 11 a. m.; flew late and high.
Delafield, Jackson County.—Very few in the air; go north with wind.
Hunter, Jackson County.—Fly north; a few drop; not enough to do serious injury.
Plattsmouth, Cass County, Nebraska.—Flying at 8.30 a. m.

July 24.

Bismarck, Burleigh County, Dakota.—Flying northwest and high.
Yellow Banks, Deuel County, Dakota.—South wind; none.
Medary, Brookings County, Dakota.—South wind; none observed.
Dell Rapids, Minnehaha County, Dakota—South wind, high; 'hoppers fly quite low, with wind.
Forestburg, Bramble County, Dakota.—Wind south; clear and pleasant; light swarms go north.
Rockport, Hanson County, Dakota.—Wind southeast; very high; 'hoppers seem reluctant to move; doing damage in some spots.
Detroit, Becker County.—Strong southeast wind; few fly northwest.
Fergus Falls, Otter Tail County.—Wind south; clear; none fly.
Benson, Swift County.—Fly north; very few.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; no 'hoppers in any great quantity.
Baxter, Lac-qui-Parle County.—Wind south, strong; clear and warm.
Montevideo, Chippewa County.—Wind southeast; but few fly; none lit.
Hector, Renville County.—South wind.
Transit, Sibley County.—Have left this town and move in southeast direction.
Waseca, Waseca County.—Flew north in large numbers; comparatively few are left.

Kanaranzie, Rock County.—None flying.
Worthington, Nobles County.—Wind south-southeast; at noon some were flying; flew late to northwest.
Middletown, Jackson County.—Fly very high over here every day (?) to northwest; no coupling yet; some stragglers come down, but don't stay.
Delafield, Jackson County.—Wind south; none in air to speak of.

July 25.

Bismarck, Burleigh County, Dakota.—Flying high to northwest; more numerous than on 24th.
Yellow Banks, Deuel County, Dakota.—South wind; none.
Medary, Brookings County, Dakota.—South wind; stragglers go northwest.
Forestburg, Bramble County, Dakota.—Wind south; clear and pleasant; light swarms go north.
Rockport, Hanson County, Dakota.—South winds, very high; very few moving; most have left here.
Detroit, Becker County.—Wind southeast, strong; few fly northwest.
Breckenridge, Wilkin County.—None here.
Fergus Falls, Otter Tail County.—Wind south; clear; none fly.
Alexandria, Douglas County.—All gone and none flying.
Saint Cloud, Stearns County.—Strong southwest wind; none seen to day.
Benson, Swift County.—Fly north, very few.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; no 'hoppers in any great quantity.
Baxter, Lac-qui-Parle County.—Wind south, strong; clear and warm.
Montevideo, Chippewa County.—Only a few fly and none seem to drop.
Willmar, Kandiyohi County.—Fly quite thick to north; none here and none alight.
Litchfield, Meeker County.—None fly.
Hector, Renville County.—South wind; 'hoppers thick, thicker, thickest.
Vicksburg, Renville County.—Are very thick, but no signs of laying yet.
Mankato, Blue Earth County.—None.
Kanaranzie, Rock County.—A few fly north.
Worthington, Nobles County.—Wind south-southeast; good breeze; not many fly.
Delafield, Jackson County.—None.
Dakota City, Humboldt County, Iowa.—Flew southeast in the afternoon; wind northwest; weather clear; some alighted.

July 26.

Bismarck, Burleigh County, Dakota.—Flying northwest; many alighting.
Yellow Banks, Deuel County, Dakota.—South wind; none.
Medary, Brookings County, Dakota.—South wind; cloudy; a little rain.
Forestburg, Bramble County, Dakota.—Wind south; clear and pleasant; light swarms go north.
Moorhead, Clay County.—Few fly northwest.
Detroit, Becker County.—Few fly northwest; strong southeast wind; what are here are not inclined to rise up.
Scambler, Otter Tail County.—Fly north.
Benson, Swift County.—Fly north; very scattering; there are a few left in county, mostly late-hatched.
Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; no 'hoppers in any great quantity.
Baxter, Lac qui-Parle County.—Wind south, strong; clear and warm.
Willmar, Kandiyohi County.—Have entirely left; seldom see even one; a few fly over in small numbers.
Hector, Renville County.—Cloudy; no 'hoppers.
Montevideo, Chippewa County.—Only a few fly and none seen to drop.
Ridgeley, Nicollet County.—All gone; none worth noticing left.
Kanaranzie, Rock County.—A few fly north.
Worthington, Nobles County.—Wind south-southeast, quite strong; could see none fly.
Delafield, Jackson County.—Very few in the air.

July 27.

Bismarck, Burleigh County, Dakota.—Flying northwest; many alighting.
Yellow Banks, Deuel County, Dakota.—Wind southwest; a few.
Medary, Brookings County, Dakota.—Cloudy; rain.
Dell Rapids, Minnehaha County, Dakota.—Wind north; 'hoppers rose and left. (Does not say whether they had already alighted or not.)
Forestburg, Bramble County, Dakota.—Cloudy; none seen.
Detroit, Becker County.—Wind about west; immense numbers fly little south of east; most of them here left with this wind.

Ocean Lake, Pope County.—Few seen for last few days; the wind has blown from all quarters.

Benson, Swift County.—Fly in afternoon quite thick almost south.

Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; plenty move southeast.

Baxter, Lac-qui-Parle County.—Wind northwest; slight breeze; move southeast in small numbers.

Hector, Renville County.—Southeast wind; 'hoppers thick.

Penn, McLeod County.—Some fly northwest.

Marshall, Lyon County.—Wind changed after noon from southerly to northwest, and nearly all the 'hoppers for miles around were up and off in a short time.

Magnolia, Rock County.—Passing southeast, some lit.

Kanaranzie, Rock County.—A few fly northeast.

Worthington, Nobles County.—Wind varying from south-southeast to northwest; none fly.

Delafield, Jackson County.—Few in the air.

Montevideo, Chippewa County.—Only a few fly and none seem to drop.

Luverne, Rock County.—Southeast; wind northwest.

Nebo, Platte County, Nebraska.—Fly southeast; wind north; clear and warm; many alighted about 4 p. m. and began eating wheat and oats.

Dakota City, Humboldt County, Iowa.—Alighted from northwest in afternoon; weather clear; wind northwest.

July 28.

Bismarck, Burleigh County, Dakota.—Flying northwest, but alighting when wind changed from northwest to southeast.

Yellow Banks, Deuel County, Dakota.—Wind northwest; warm; came up at 11 o'clock pretty thick; continued much the same till within half an hour of sunset; may have flown in the night, as none lit before sunset, and a good many were found in the morning. They were very low and lost in height, but not dense as at other times.

Gary, Deuel County, Dakota.—Came again to-day in millions from northwest; none lit; wind has been from south for five days, with no 'hoppers.

Medary, Brookings County, Dakota.—Wind northwest; clear; immense swarms go southeast all day; some lit east of here.

Dell Rapids, Minnehaha County, Dakota.—Wind west in morning, then northwest; immense numbers fly southeast, with wind, from 12 to 6.

Forestburg, Bramble County, Dakota.—Wind northwest; going southe. st.

Crookston, Polk County.—Slight northwest wind; at 2.30 p. m. fly southeast very thick.

Detroit, Becker County.—Wind southeast; none fly.

Audubon, Becker County.—Fly in large numbers from north 20° west to south 20° east.

Township 136, *Range* 45, *Wilkin County.*—Wind west-northwest; 'hoppers flying; ours rise; not one to be seen at sundown on grass or grain.

Long Prairie, Todd County.—Large numbers go southeast. [Southeast wind; cool and clear; go northwest in moderate numbers.] (?) (Seems to be an error of date.)

Paynesville, Stearns County.—None fly since 16th; to-day considerable numbers go southeast.

Saint Wendell, Stearns County.—Clear; strong northwest winds; began to pass southeast; at 11.30 quite a number passed for two or three hours; a few lit.

Benson, Swift County.—Flying in afternoon southeast; quite thick.

Lac-qui-Parle, Lac-qui-Parle County.—Wind northwest; plenty go southeast.

Baxter, Lac-qui-Parle County.—Wind northwest, strong; go southeast in large numbers.

Brookfield, Renville County.—Small swarms fly southeast; few seen since 10th.

Hector, Renville County.—Wind northwest; 'hoppers thick.

Marshall, Lyon County.—Air full all day; go southeast, very high.

Pipe Stone, Pipe Stone County.—Wind northwest; fly in immense swarms; none alighted.

Mount Lake, Cottonwood County.—Strong northwest wind; fly south; very numerous.

Madelia, Watomoan County.—Passed southeast thickly.

Mankato, Blue Earth County.—Large swarms fly southeast; none lit.

Luverne, Rock County.—Fly southeast; strong wind; large swarms; not alighting at 3 p. m.

Clinton, Rock County.—Fly from northwest; lit in south part of county, and in Lyons County, Iowa; no damage done yet.

Magnolia, Rock County.—Large swarms go southeast and south; nine hours passing.

Kanaranzie, Rock County.—Large swarms passed southeast and alighted; left on the 31st.

Little Rock, Nobles County.—Wind from northwest; air full; go southeast; one falls occasionally.

Worthington, Nobles County.—Wind northwest to west; afternoon a heavy flight fly in large swarms southerly.

Bigelow, Nobles County.—Clear; high northwest wind; at 2 p. m. a great swarm fly over southeast; more than on any day previous.

Christiana, Jackson County.—Fly very thick; some lit.

Delafield, Jackson County.—Wind northwest; quite strong. At 1 p. m. a small swarm, increasing in numbers till 3 p. m., then quite numerous; more lit than any day during the season.

Hunter, Jackson County.—Immense numbers go southeast.

Center Creek, Martin County.—Wind northwest; flew over pretty thick, and a good many dropped down. I think they were the tired ones.

Tenhassen, Martin County.—A few lit, and still remain (August 3); do not seem to do any damage.

Sioux City, Iowa.—Immense swarms have been flying east since morning; but few came down.

Lyons County, Iowa.—*Vide* Clinton Rock County.

Ponca, Dixon County, Nebraska.—Go southeast.

July 29.

Bismarck, Burleigh County, Dakota.—Flying northwest in considerable numbers.

Yellow Banks, Deuel County, Dakota.—High southwest wind; none.

Gary, Deuel County, Dakota.—South wind, a gale; fly high and very scattering.

Medary, Brookings County, Dakota.—South wind, strong; a few straggling to northwest.

Dell Rapids, Minnehaha County.—South wind; some flying.

Crookston, Polk County.—At 2 p. m. fly northwest; high, and very thick.

Moorehead, Clay County.—Fly in great numbers northwest nearly all day.

Detroit, Becker County.—Wind southeast; none fly.

Audubon, Becker County.—Fly northwest; lit in limited numbers a few miles northwest of here.

Long Prairie, Todd County.—Southeast wind; clear and warm; go northwest; thick and very high; some lit.

Paynesville, Stearns County.—Fly northwest; came down in great numbers.

Saint Wendell, Stearns County.—Fly northwest; wind southeast; many lit.

Benson, Swift County.—Began to fly about 10 o'clock in northwestern direction; could see them fly till almost sundown; but I have heard of no large swarms coming down in any of the adjoining counties.

Lac-qui-Parle, Lac-qui-Parle County.—Wind southeast; none moving.

Baxter, Lac qui-Parle County.—Wind south, strong; fly north in considerable numbers.

Hector, Renville County.—None.

Brookfield, Renville County.—Small swarms fly northwest.

Penn, McLeod County.—Fly north quite thick; a few lit; stopped but a few hours.

Marshall, Lyon County.—Wind south; few flying.

Kasota, Le Sueur County.—Fly north all day; quite a number here yet, but not enough to do damage.

Le Sueur Centre, Le Sueur County.—Fly northwest for quite a while.

Mount Lake, Cottonwood County.—Strong south wind; a few drop, but not many flying.

Mankato, Blue Earth County.—Fly north.

Kanaranzie, Rock County.—Some fly northwest.

Worthington, Nobles County.—Wind southeast again; could see but few in the air.

Delafield, Jackson County.—Wind south, very strong.

Center Creek, Martin County.—Strong south wind.

Winnebago City, Faribault County.—Fly northwest.

Freeborn, Freeborn County.—Wind southeast; fly northwest; very high; few lit.

Geneva, Freeborn County.—Have been leaving since 20th (*vid.* 20th); to-day a good many have gone.

Ponca, Dixon County, Nebraska.—Fly southeast.

Nebo, Platte County, Nebraska.—Flying northeast; wind south.

July 30.

Bismarck, Burleigh County, Dakota.—Flying in various directions, their general course being northwest.

Yellow Banks, Deuel County, Dakota.—High southwest wind; none.

Medary, Brookings County.—High south wind; some fly northwest.

Dell Rapids, Minnehaha County.—High south wind; some fly low.

Moorhead, Clay County.—Few fly northwest; none seen laying yet.

Detroit, Becker County.—Very strong southeast wind; a few fly northwest.

Long Prairie, Todd County.—Wind southeast; clear and warm; go northwest in moderate numbers; some lit.

Benson, Swift County.—Fly in afternoon quite thick, northwest.
Baxter, Lac qui-Parle County.—Strong southeast wind; clear and warm; none fly.
Lac-qui-Parle, Lac-qui-Parle County (vid. 29th).—Nearly all have left here.
Hector, Renville County.—South wind, very strong; fly thick, very high.
Marshall, Lyon County.—South wind; all quiet.
Mankato, Blue Earth County.—Few fly nor hwest, very high; fly north.
Worthington, Nobles County.—Air full, returning north; fly very high; wind south-southeast, backing to north-northeast; in afternoon a heavy flight on last-named wind.
Delafield, Jackson County.—Wind south; none to speak of.
Nebo, Platte County, Nebraska.—Fly north; wind south.

July 31.

Bismarck, Burleigh County, Dakota.—Flying in different directions at different altitudes.
Yellow Banks, Deuel County, Dakota.—South wind and rain till 11 a. m.; wind changed to northeast; a good many 'hoppers from 1 to 3 p. m.
Medary, Brookings County, Dakota.—Wind northwest; rain in morning; go south in afternoon.
Dell Rapids, Minnehaha County, Dakota.—Wind northwest; many fly with wind late in the afternoon.
Moorhead, Clay County.—Strong northwest wind; quite a number flew southeast.
Long Prairie, Todd County.—No observations.
Paynesville, Stearns County.—A few fly this afternoon to south.
Benson, Swift County.—In morning, rain; flew southwest in afternoon; quite a good many.
Baxter, Lac-qui-Parle County.—No wind; cloudy, and some rain; none fly.
Hector, Renville County.—Still thick.
Marshall, Lyon County.—Showers in morning; 'hoppers fly southeast in afternoon; many left about here; others were very high.
Magnolia, Rock County.—Fly south; many leave.
Kanaranzie, Rock County.—The large swarms that alighted on the 28th left; they waited for a favorable wind to go south.
Worthington, Nobles County.—Wind from northwest to northeast; rained a little in afternoon; after dinner, wind northwest; good flight till late.
Delafield, Jackson County.—Late in afternoon go south; wind northwest; a few lit.
Hunter, Jackson County.—Fly south, immense numbers.
Tenhassen, Martin County.—Morning rainy; wind southeast; afternoon rainy; wind northwest.
Republican City, Harlan County, Nebraska.—Cloudy till 8 a. m.; wind light; 'hoppers passing over from 9 to 3; vast numbers alighting.
Nebo, Platte County, Nebraska.—'Hoppers very stupid and helpless.
Adamson, Rooks County, Kansas.—Fly south; wind north.
Norton, Norton County, Kansas.—Fly south; wind northeast.
Laverne, Rock County.—Fly south; many leaving.

August 1.

Bismarck, Burleigh County, Dakota.—Same as July 31.
Yellow Banks, Deuel County, Dakota.—Cool; wind southwest; a few.
Gary, Deuel County, Dakota.—A few fly southeast with wind.
Medary, Brookings County, Dakota.—Wind northwest; large swarms go south.
Dell Rapids, Minnehaha County.—Wind northwest; considerable numbers flying.
Fort Sisseton, Dakota.—Northwest wind—15 miles per hour; fly southeast.
Fergus Falls, Otter Tail County.—Flying from west and northwest.
Long Prairie, Todd County.—West wind; go east-southeast, thick.
St. Cloud, Stearns County.—Fly south in swarms; some few lit.
Paynesville, Stearns County.—Fly southeast; not in great numbers.
Benson, Swift County.—Fly little east of south, quite thick.
Baxter, Lac-qui-Parle County.—Wind northwest; good breeze; clear.
Hector, Renville County.—Wind northwest; 'hoppers with wind.
Beaver Falls, Renville County.—An extensive migration to the southeast.
Marshall, Lyon County.—Fly southeast, very high.
Pipestone, Pipestone County.—Rained in morning; clear at noon; at 2 p. m. wind northwest; fly southeast, very thick.
Madelia, Watonwan County.—Go south, quite thick.
Wilton, Waseca County.—Fly in large numbers to southeast.
Magnolia, Rock County.—Large swarms go east.
Worthington, Nobles County.—Fly over in large numbers most all day; not very stiff breeze blowing; seem to go southwest; fly very high, and none lit in the county; wind light from west to northwest; quite a good flight in afternoon.
Hunter, Jackson County.—Go south in large numbers.
Delafield.—Go south; wind northwest; none lit.

Tenhassen, Martin County.—Fly southeast; wind northwest.
Plymouth, Iowa.—Fly little east of south by the millions.
Tabor, Fremont County, Iowa.—'Hoppers flying northeast; wind southwest.
Norton, Norton County, Kansas.—'Hoppers flying southeast.
Adamson, Rooks County.—'Hoppers flying southeast; leaving.
Nebo, Platte County, Nebraska.—Go west; wind southeast.
Lyle, Mower County.—Go southeast.
Luverne, Rock County.—Large swarms fly southeast.

August 2.

Bismarck, Burleigh County, Dakota.—Same as July 31.
Yellow Banks, Deuel County, Dakota.—Wind northeast; warm; a good many 'hoppers.
Gary, Deuel County, Dakota.—Fly again by millions; first seen go southeast about 9 a. m.; about 10 p. m. wind changed to northeast, and 'hoppers go southwest till 5 o'clock.
Medary, Brookings County.—Wind light from southeast; great swarms move slowly to northwest all day; moved so slowly that their direction could hardly be determined.
Dell Rapids, Minnehaha County.—Wind south; many flew north.
Glyndon, Clay County.—What little wind there is from north; fly south, thick; haven't heard of any dropping.
Audubon, Becker County.—Fly from north 15 degrees west to south 15 degrees east; afterward directly south till 5 p. m.
Breckenridge, Wilkins County.—Fly southeast.
Fergus Falls, Otter Tail County.—Fly over from west and northwest.
Alexandria, Douglas County.—Fly southeast in considerable numbers; none lit.
Osakis, Douglas County.—Fly southeast in large numbers; but few lit.
Long Prairie, Todd County.—Wind northwest, cool and clear; go southeast, thick; all of ours that could get away went; had been quite thick, but did no perceptible damage since July.
Paynesville, Stearns County.—Fly nearly due south in considerable numbers; first saw them little before noon; flew till between 4 and 5 o'clock; those that lit about a week ago have nearly all left.
St. Cloud, Stearns County.—Fly south this morning; some few lit.
Clear Lake, Sherburne County.—Air full; fly southeast, very low; some alight.
Anoka, Anoka County.—Millions fly over.
Benson, Swift County.—Fly west of south, very thick; have not seen any lighting down in this place for a long time.
Baxter, Swift County.—Wind northwest, very slight; clear and hot; very few fly.
Willmar, Kandiyohi County.—Fly southeast.
St. Paul, Ramsey County.—Fly southeast, high.
Minneapolis, Hennepin County.—Fly southeast, high.
Palmyra, Renville County.—Thick swarms go southeasterly all day.
Hector, Renville County.—Wind northwest; fly with wind.
Glencoe, McLeod County.—Fly southeast, very thick; don't seem to alight.
Penn, McLeod County.—Fly south, very thick; most of them high up; some lit.
Shakopee, Scott County.—Fly southeast in numberless quantities at noon.
St. Peter, Nicollet County.—Fly southeast, very thick; weather clear and pleasant.
Ridgeley, Nicollet County.—Some fly each fine day; don't know of any alighting or laying.
Le Sueur Centre, Le Sueur County.—Fill the heavens for two consecutive hours; go about two points east of south; wind west, quite brisk.
Morristown, Rice County.—Fly from northwest; seem to darken the sun.
Fairibault, Rice County.—Fly south by southwest, quite thick; none fall at present.
Northfield, Rice County.—Flew over in considerable numbers.
Dundas, Rice County.—Millions fly quite high in a southerly direction; occasionally a straggler falls.
Pipestone, Pipestone County.—Wind northwest; began to fly about 10 o'clock; heavy; some lit.
Madelia, Watonwan County.—Quite thick; go south.
Mankato, Blue Earth County.—Air full; fly south, thick and low.
Waseca, Waseca County.—Millions fly over to south.
Wilton, Waseca County.—Fly in large numbers to southeast.
Kanaranzie, Rock County.—Some fly northwest.
Magnolia, Rock County.—Fly southwest; very numerous; large squads lit in some places.
Vienna, Rock County.—Wind northeast; many lit; damage to gardens and corn.
Worthington, Nobles County.—Almost a calm in morning; about 11 a. m., 'hoppers were up in the air high, circling upward till about 1 p. m., when wind set in from southeast, and there was a very heavy flight till very late; none lit.

Middleton, Jackson County.—Main army passed very slow from north; lit at head of Spirit Lake, Iowa.
Hunter, Jackson County.—Go south; immense numbers.
Delafield, Jackson County.—Go southwest; moderate wind from west of north. Those here (*vide* July 31) left.
Tenhassen, Martin County.—Wind northwest; fly southeast: air actually full.
Freeborn, Freeborn County.—Wind northwest: clear; heavy swarms go southeast. Began to fly at 9 o'clock; at 1 the air is full; very high; none alighted.
Le Roy, Mower County.—A cloud flew over in afternoon.
Plymouth, Iowa County.—Fly little east of south by the millions.
Marshall, Lyon County.—Many go southwest.
Lyle, Mower County.—Go southeast.
Luverne, Rock County.—Fly southeast in great numbers: largest swarm yet.
Glencoe, Dodge County, Nebr.—'Hoppers fly southwest. Alighted when wind changed.
Pleasant Home, Polk County, Nebr.—'Hoppers fly with the wind from 2 to 11 (?)
Nebo, Platte County, Nebr.—Fly west; wind southeast.

August 3.

Bismarck, Burleigh County, Dakota.—Seen flying daily in different directions, their general course being northwest, but moving in different directions at different altitudes.
Yellow Banks, Deuel County Dakota.—High southwest wind; none.
Medary, Brookings County, Dakota.—Southeast winds; some fly northwest.
Dell Rapids, Minnehaha County, Dakota.—Many going northwest.
Audubon, Becker County.—Wind from south 20° east; none returning.
Benson, Swift County.—Very few fly northwest in afternoon.
Baxter, Lac-qui-Parle.—Wind southeast; clear in morning; cloudy in afternoon; none fly.
Hector, Renville County.—Cloudy; no 'hoppers.
Penn, McLeod County.—Wind south; a few went north; those that lit on the 2d left.
Pipestone, Pipestone County.—Fly north; a good many lit.
Wilton, Waseca County.—Wind changed; some few fly north.
Vienna, Rock County.—Wind southeast; 'hoppers do not leave.
Worthington, Nobles County.—Wind southeast nearly; very few fly.
Delafield, Jackson County.—A few go north; wind south.
Tenhassen, Martin County.—Calm.
Lyle, Mower County.—Go southeast.
Nebo, Platte County, Nebr.—Go west; wind southeast.
Norton, Norton County, Kans.—Go southwest.

August 4.

Bismarck, Burleigh County, Dakota.—Flying in various directions, with the currents of wind.
Yellow Banks, Deuel County, Dakota.—High southwest wind; none.
Medary, Brookings County, Dakota.—Strong south wind.
Benson, Swift County.—Very few; fly north.
Baxter, Lac qui-Parle County.—Wind south; clear and warm; none fly.
Marshall, Lyon County.—Wind south; none fly.
Hector, Renville County.—Wind northwest; 'hoppers as usual.
Mankato, Blue Earth County.—A few stragglers fly northward.
Vienna, Rock County.—Wind south; 'hoppers do not leave.
Worthington, Nobles County.—Wind southeast; scarcely any fly.
Delafield, Jackson County.—Wind south; very strong; have seen none.
Lyle, Mower County.—Go southeast.

August 5.

Bismarck, Burleigh County, Dakota.—Same as August 3 and 4.
Yellow Banks, Deuel County, Dakota.—High southwest wind; none.
Medary, Brookings County, Dakota.—Light south winds; none seen flying.
Benson, Swift County.—Cloudy; none seen.
Baxter, Lac-qui-Parle County.—Wind southwest: cloudy and warm; none fly.
Hector, Renville County.—Cloudy and still; no 'hoppers.
Marshfield, Lincoln County.—Wind south; none fly.
Pipestone, Pipestone County.—Those that lit on 2d flew south.
Vienna, Rock County.—Wind southeast; 'hoppers do not leave.
Worthington, Nobles County.—Wind south and southwest; could not see any fly.
Delafield, Jackson County.—Wind south very strong; not a 'hopper seen.
Lyle, Mower County.—Go southeast.
Glencoe, Dodge County, Nebraska.—Wind from northwest; 'hoppers fly over.
Genoa, Platte County, Nebraska.—'Hoppers go north; wind south-southwest.
Norton, Norton County, Kansas.—Flying very high, southwest.

August 6.

Bismarck, Burleigh County, Dakota.—Same as 2d and 3d.
Medary, Brookings County, Dakota.—Wind northwest; great swarms pass south.
Benson, Swift County.—Fly very thick west of south; very high.
Baxter, Lac-qui-Parle County.—Wind northwest; considerable numbers go southeast.
Beaver Falls, Renville County.—*Vid.* 9th.
Ackley, Hardin County, Iowa.—Fly southerly.
Palmyra, Renville County.—Not great numbers flying for two weeks past, except on 2d; have not alighted all summer.
Palmyra, Renville County.—Thick in air going southeasterly direction; none lit.
Hector, Renville County.—'Hoppers settled thick; wind northwest.
Hastings, Dakota County.—Fly over at 2.40 rate to southeast in large numbers; none came down.
Charlestown, Redwood County.—Flying thick to-day.
Between Niobrara and Yankton.—Fly southward dense and high.
Ridgeley, Nicollet County.—Go southeast; but few come down; none seen depositing eggs.
Dundas, Rice County.—Air full; several fell to the ground and died soon after.
Mankato, Blue Earth County.—Clear wind north; immense swarms fly south from 10 a. m. till near sundown.
Vienna, Rock County.—Wind changed north; 'hoppers leave.
Worthington, Nobles County.—Wind northwest; quite warm last night; heavy flight this morning.
Christiana, Jackson County.—'Hoppers are gone (*vid.* July 28).
Delafield, Jackson County.—Wind northwest; small swarm fly south.
Brownsdale, Mower County.—Fly over from 11 till 3; all were very high; none came to the ground.
Genoa, Platte County, Nebraska.—Fly north; wind south and southwest.
Norton, Norton County, Kansas.—Fly southwest.

August 7.

Bismarck, Burleigh County, Dakota.—'Hoppers decreas'ng in numbers.
Fort Sisseton, Burleigh County, Dakota.—Fly southeast; wind northwest, 20 miles per hour.
Medary, Brookings County, Dakota.—High northwest wind; none.
Benson, Swift County.—Fly thick due south.
Baxter, Lac-qui-Parle County.—Wind northwest; good breeze; fly southeast; a very few lit.
Beaver Falls, Renville County.—*Vid.* 9th.
Hector, Renville County.—Wind north; 'hoppers rising (*vid.* 6th).
Ackley, Hardin County, Iowa.—Fly southerly.
Penn, McLeod County.—Fly southeast high, and as thick as any previous day; a very few sickly ones dropped.
Ridgeley, Nicollet County.—Go southeast; but few came down; none seen depositing eggs.
Cedar County, Nebraska.—Few fly south.
La Sueur, La Sueur County.—Air has been full of flying 'hoppers at times during the past week; have not heard of any alighting.
Northfield, Rice County.—Flew over in considerable numbers.
Magnolia, Rock County.—Go south; many leave here; *vid.* August 2, Magnolia and Vienna.
Luverne, Rock County.—Go south.
Worthington, Nobles County.—Light southeast wind; none fly.
Seward, Nobles County.—Have been flying every day; generally go west (refers to all summer).
Delafield, Jackson County.—Wind southwest in part of morning, northwest in afternoon; none fly.
Glencoe, Dodge County.—Flying southeast all day; clear.

August 8.

Bismarck, Burleigh County, Dakota.—'Hoppers still flying, but decreasing in numbers.
Medary, Brookings County, Dakota.—Wind northwest; light swarms go south.
Benson, Swift County.—Fly due south; not quite so thick.
Baxter, Lac-qui-Parle County.—Wind northwest; clear and cool; small numbers fly over southeast; a few drop.
Beaver Falls, Renville County.—*Vid.* 9th.
Hector, Renville County.—Wind north; 'hoppers flying high.
Palmyra, Renville County.—Thick in the air; going in southeasterly direction.
Carver, Carver County.—Flying over occasionally all last week (*vid.* 7th).
Ridgeley, Nicollet County.—But few came down; none seen to deposit eggs.

Magnolia, Rock County.—Go southeast.
Worthington, Nobles County.—Brisk north-northwest wind; heavy flight; high and late.
Delafield, Jackson County.—Wind northwest; small swarm fly south.
Hunter, Jackson County.—Go in less numbers; a number alighted.
Alden, Freeborn County.—Have all left; but are to be seen in air every day going with the wind; have not commenced to deposit eggs to any extent.
Ackley, Hardin County, Iowa.—About the 8th, flew for a day or two quite thick; alighted quite thickly nine miles north of Ackley, and to some extent in and around Ackley.
Lyle, Mower County.—Fly southeast.
Luverne, Rock County.—Fly southeast.
Patron, Butler County, Nebraska.—Fly southwest; wind south. (?)

August 9.

Bismarck, Burleigh County, Dakota.—Still flying in decreased numbers.
Medary, Brookings County, Dakota.—From 9th to 27th none seen.
Benson, Swift County.—Fly south in afternoon; not so many as on 8th.
Baxter, Lac-qui-Parle County.—Fly southwest; slight northwest wind.
Hector, Renville County.—Wind north; flying high. During the past three days immense swarms have winged their way over this locality, going for the most part in a southeasterly direction.—[*Renville Times*, Beaver Falls.
Waseca, Waseca County.—Flying over in large numbers very high.
Magnolia, Rock County.—Go southwest.
Worthington, Nobles County.—Wind about northwest; heavy flight, high and late.
Hunter, Jackson County.—Flew very thick to south-southeast; those that lit on 8th left.
Delafield, Jackson County.—Wind northwest; fly south; small swarm; none lit.
Winnebago City, Faribault County.—A few fly southeast.
Luverne, Rock County.—Fly southwest.
Genoa, Platte County, Nebraska.—Wind south-southwest; 'hoppers fly north.
Glencoe, Dodge County, Nebraska.—Fly southwest all day; some alighting.
Pleasant Home, Polk County.—Fly with the wind.
Norton, Norton County, Kansas.—Fly northwest; wind southeast; few alighting.

August 10.

Bismarck, Burleigh County, Dakota.—Nearly all have ceased flying.
Benson, Swift County.—Small numbers fly little west of north; none alighting or depositing eggs that I had heard of in any part of this county.
Baxter, Lac-qui-Parle County.—Slight southeast wind; clear and warm; very few fly northwest.
Hector, Renville County.—Wind southeast; fly with wind.
Magnolia, Rock County.—Go northwest.
Worthington, Nobles County.—Wind southeast; none fly.
Delafield, Jackson County.—South wind; none in air.
Genoa, Platte County, Nebraska.—Fly north; wind south-southwest.
Lyle, Mower County.—Fly southeast.
Luverne, Rock County.—Fly northwest.

August 11.

Bismarck, Burleigh County, Dakota.—Have all disappeared; none flying or on the ground.
Baxter, Lac-qui-Parle County.—Slight northwest wind; clear and hot; very few fly southeast; no eggs have been deposited by those that have dropped.
Hector, Renville County.—Wind northwest; fly very high.
Magnolia, Rock County.—Go south and southwest, varying with the wind.
Luverne, Rock County.—Disappeared several days since; have been seen going south, but did not alight.
Worthington, Nobles County.—Light southeast wind; none seen.
Delafield, Jackson County.—Wind southeast in morning, northeast at noon, and northwest at 3 p. m., after which a few were seen flying.
Lyle, Mower County.—Go southeast.
Genoa, Platte County, Nebraska.—Fly north; wind south-southwest.
Glencoe, Dodge County, Nebraska.—Fly southeast.
Patron, Butler County, Nebraska.—Swarms departing.
Norton, Norton, County, Kansas.—Fly southeast very high.

August 12.

Benson, Swift County.—A few fly in afternoon about due south.
Hector, Renville County.—None.
Worthington, Nobles County.—Wind northwest; cloudy; none seen.

Delafield, Jackson County.—Wind northwest; a few in the air.
Center Creek, Martin County.—About all left.
Lyle, Mower County.—Go southeast.
Luverne, Rock County.—Go southeast.
Genoa, Platte County, Nebraska.—Fly north; wind south-southwest.
Glencoe, Dodge County, Nebraska.—Some fly over to northwest.
Patron, Butler County, Nebraska.—Departing.
Norton, Norton County, Kansas.—Fly west of south; air very full.
Tabor, Clay County, Kansas.—Fly south; wind northwest; quite dense.

August 13.

Benson, Swift County.—A few fly in afternoon a little west of south; a little cloudy.
Worthington, Nobles County.—Wind northwest; cool; a few seen; fly high.
Delafield, Jackson County.—Wind northwest in morning, and north at 1 p. m.; cloudy; none seen.
Tabor, Clay County, Kansas.—Few fly northeast.
Alma, Clay County, Kansas.—Fly southwest.
Lyle, Mower County.—Fly southeast.
Luverne, Rock County.—Fly southwest.

August 14.

Benson, Swift County.—Scattering; very few to be seen flying south.
Marshall, Lyon County.—When wind is north they are in the air; mostly very high; seem to be stragglers.
Worthington, Nobles County.—Wind varying; none seen.
Delafield, Jackson County.—Wind northwest; none pass over.
Glencoe, Dodge County, Nebraska.—Fly southeast in great abundance.
Alma, Dodge County, Nebraska.—Fly southwest; few alighting.
Sioux City, Woodbury County, Iowa.—Seen flying.

August 15.

Delafield, Jackson County.—Wind west; not one to be seen.
Tabor, Clay County, Kansas.—Fly northwest; wind south; returning.
Glencoe, Dodge County, Nebraska.—Fly southeast in great abundance.
Omaha, Douglas County, Nebraska.—A few flying.
Sioux City, Woodbury County, Iowa.—Flying.

August 16.

Delafield, Jackson County.—Wind west; not one to be seen.
Glencoe, Dodge County, Nebraska.—Fly southwest abundantly.

August 17.

Delafield, Jackson County.—Wind southwest; none.

August 18.

Hector, Renville County.—11th to 18th none seen.
Marshall, Lyon County.—None fly for past week.
Delafield, Jackson County.—None flying.

August 19.

Delafield, Jackson County.—Wind southwest; none seen; have seen one in act of depositing eggs, but no coupling; have found ten males to one female.
Genoa, Platte County, Nebraska.—Go north; wind south.

August 21.

Christiana, Jackson County.—Flew very thick east; were very high, and a very few lit.
Genoa, Platte County, Nebraska.—Wind south and southwest; 'hoppers fly north till 25th.

August 28.

Medary, Brookings County, Dakota.—None seen since August 8 till to-day; a few stragglers go south.

August 29.

Genoa, Platte County, Nebraska.—Wind from west; 'hoppers fly south.

August 30.

Genoa, Platte County, Nebraska.—Fly north; wind from southwest.

August 31.

Genoa, Platte County, Nebraska.—Fly south from 11 a. m. to 4 p. m.

September 1.

Genoa, Platte County, Nebraska.—Fly south and southwest; wind north and northeast from 1st to 21st.

September 2.

Medary, Brookings County, Dakota.—A few stragglers go south.
Ackley, Hardin County, Iowa.—Fly over to south very high.

September 3.

Waseca, Waseca County.—A few go north very high.
Ackley, Hardin County, Iowa.—Fly over to south very high.

September 4.

Ackley, Hardin County, Iowa.—Same as 3d and 4th.

September 16.

Camp Supply, Indian Territory.—'Hoppers fly southeast; wind south in morning, north in afternoon. None lit.

September 29.

Calvert, Texas.—Fly southward at noon and all alighting; wind north.

APPENDIX XIV.

Did any of the locusts remain in your locality after the departure of those which hatched and developed with you ; and, if so, were any of them noticed to lay eggs?

ARKANSAS.

Bentonville, Benton County.—None ; No. But few were noticed to remain over summer. None laid eggs.—[J. W. Williams.

Carrollton, Carroll County.—None remained.—[Jno. L. Sims.

COLORADO.

Colorado Springs, El Paso County.—No locusts hatched here this year.—[H. McAllister, jr.

Denver, Arapahoe County.—No ; none remained.—[C. L. Campbell.

Fort Collins, Larimer County.—One of my neighbors said to me that on his place the locusts that hatched remained and died on the field. He did not observe that they deposited any eggs.—[R. Q. Tenney.

Georgetown, Clear Creek County.—None remained.—[H. W. Pollitz.

Greeley, Weld County.—No locusts remained in this locality after those departed which hatched here.—[G. B. Hight.

Howardsville, San Juan County.—The few locusts that hatched in this region remained here all summer and fall.

La Porte, Larimer County.—None remained.—[E. N. Garbutt.

Larkspur, Douglas County.—But few staid ; some laid eggs.—[W. R. Leverson.

Pleasant Valley, Tremont County.—The locust hatched and developed with us last spring, but in July and August they left by degrees. No eggs deposited.—[S. C. Brown.

Pueblo, Pueblo County.—None remained.—[Judge Hallett.

Saguache, Saguache County.—None.—[W. B. Telton.

Wheatland, Larimer County.—None remained ; in fact never developed. All at once were missing. Scarcely any of them ever flew.—[J. C. Abbott.

IOWA.

Algona, Kossuth County.—After our locusts left, some from Minnesota stopped about forty-eight hours here ; no eggs laid.—[H. C. McCoy.

Alta, Buena Vista County.—A few were here the whole season, but they were very small ; left no eggs.—[Crowell & Thompson.

Ames, Story County.—A few have been with us the whole season ; have noticed none laying eggs.—[C. E. Bessey.

Athol, Sioux County.—No locusts remained here more than three or four days at a time after the departure of those which hatched and developed here, and none of them were noticed to lay.—[W. J. Newell.

Carrollton, Carroll County.—None remained.—[Andrew Barr.

Chickasaw, Chickasaw County.—It is frequently the case that a number do remain from late hatching or other cause, not being fully developed and ready for flight. Those that remain lay their eggs.—[William Tucker.

Council Bluffs, Pottawattamie County.—A very few remained all the season, but no eggs were laid.

Denison, Crawford County.—None. No.—[M. H. Wygant.

Des Moines, Polk County.—Yes ; very few.—[William H. Fleming.

Estherville, Emmett County.—Not to any extent. For a period of six weeks the air was filled with grasshoppers every fair day ; some alighted to rest apparently ; none laid eggs, nor could any signs of eggs be found in them as late as the 1st of August. None staid any length of time.—[W. C. Jarvis.

Lemars, Plymouth County.—As fast as the locusts developed they left. None laid eggs, to my knowledge.—[F. M. Jenkins.

Little Sioux, Harrison County.—Yes ; many remained till they died of disease. I do not know of their depositing eggs.—[A. H. Gleason.

Malvern, Mills County.—I think none remained; but am not confident.—[Rev. J. R. Brown.

Onawa, Monona County.—Yes; before those that hatched reached maturity the locusts began to come in from the south. This continued till about the 20th July, when they began returning from the north. On my farm we were at no time without locusts from hatching until the latter part of September. I observed no eggs laid.—[Addison Oliver.

Sac City, Sac County.—All left.—[Washington Allen.

Sheridan, Van Buren County.—Never had any in this locality.—[A. Eides.

Sheldon, O'Brien County.—Some remained; laid no eggs.—[J. C. Elliot.

Shelby, Shelby County.—Yes; but they died of disease. No eggs laid.—[W. H. Brown.

Sidney, Fremont County.—It would be a difficult matter to tell just when the grasshoppers did leave, as they continued to fly from different directions, and occasionally light down and remain for a short time; but in no case did we notice them depositing eggs. None staid with us.—[G. V. Swearingen.

Sioux County.—Some remained; laid no eggs.

Sioux City, Woodbury County.—Only a few remained; none were noticed to lay eggs.—[William R. Smith.

Spirit Lake, Dickinson County.—No locusts remained in this locality.—[Emmet F. Hill.

Tabor, Fremont County.—No.—[J. F. Sanborn.

Webster City, Keokuk County.—A few remained, but soon died off. No eggs were deposited as far as I can learn.—[C. Aldrich.

KANSAS.

Abilene, Dickinson County.—None remained.—[W. T. Davidson.

Atchison, Atchison County.—No grasshoppers hatched except in the western part of the county; no flight was made by those hatched; none laid eggs. A few of the locusts remained after time of departure, but none were noticed to lay eggs.—[C. W. Johnson.

Belleville, Republic County.—Not many. No.—[J. P. Heaton.

Belle Plaine, Sumner County.—None remained.—[H. C. St. Clair.

Beloit, Mitchell County.—No.

Buffalo, Wilson County.—There did a few 'hoppers remain all summer. I have seen them every day when able to be out; and as late as to-day, October 31, I saw a pure red-leg near my smoke-house door.

Bunker Hill, Russell County.—A few remained, but did not appear to lay any eggs. Disappeared early in the season.

Burlington, Coffey County.—None remained; no eggs laid.—[B. L. Kingsbury.

Centralia, Nemaha County.—All left.

Chanute, Neosho County.—None remained.

Cherryvale, Montgomery County.—None remained.—[C. G. Brooks.

Claytonville, Brown County.—Numbers of the locusts that hatched here were not strong enough to fly, and were killed off by red parasites; none laid eggs.—[W. M. Robertson.

Concordia, Cloud County.—Very few; none noticed to lay eggs.—[C. F. Moore.

Cope, Jackson County.—None, except a few of late hatching that still remain.

Ellsworth, Ellsworth County.—All died and vanished early in the season; no eggs laid.

Elivon, McPherson County.—Not any.

Emporia, Lyon County.—Locusts remained when they hatched, but died or disappeared suddenly.—[S. C. Delap.

Eureka, Greenwood County.—Do not think any locusts hatched in this county last spring ever left. They came forth in myriads, would be alive for a few days, and then vanish without depositing eggs.

Farland, McPherson County.—I believe a very few remained, and are even now laying their eggs.

Fairfax, Osage County.—None remained.

Fenwick, Republic County.—None staid that I know of.—[D. Doran.

Galesburg, Neosho County.—No locusts remained in this section after the departure of those developed here.—[D. B. Skeels.

Geneva, Allen County.—None noticed as remaining.—[Van Deman.

Girard, Crawford County.—Locusts did remain where they hatched, but seemed to vanish without ovipositing.

Great Bend, Barton County.—A few hatched in this county in gardens and wheatfields early in May; did no damage; laid no eggs; disappeared very soon.—[D. J. Evans.

Hays City, Ellis County.—No locusts here in spring.

Hiawatha, Brown County.—None remained; no eggs here. Some remained, but laid no eggs.—[E. M. Pratt.

Hutchinson, Reno County.—None remained.—[S. T. Kelsey.

Industry, Dickinson County.—Very few remained. None noticed to lay eggs.—[G. J. Smart.

Indianola, Butler County.—None remained.
Iola, Allen County.—No.—[H. F. Rice.
Irving, Marshall County.—Only a few scattered individuals remained after the general flight. None were known to deposit eggs.—[B. T. Ward.
Jewell City, Jewell County.—All left.—[Harrison Keely.
Junction City, Davis County.—Very few hatched; none were noticed to lay eggs. None remained. No eggs were laid.—[Chas. S. Davis.
Lane, Franklin County.—No.—[Jas. Hanway.
Le Roy, Coffey County.—A few remained. No eggs that I can hear of. None noticed.—[M. F. White.
Logan, Phillips County.—Very few hatched, and none remained.—[Jno. Benjamin.
Lyndon, Osage County.—No.
Lyons, Rice County.—None remained; died before they were large enough to fly.
Manhattan, Riley County.—I think none remained; I noticed none.—[N. A. Adams.
McPherson, McPherson County.—They laid no eggs; but few remained.
Medina, Jefferson County.—All left.
Millwood, Leavenworth County.—A few came in this fall and are now here, but laid no eggs.
Neosho Falls, Woodson County.—No. No. No.—[J. T. Goodnow.
Newton, Harvey County.—None remained with us.—[F. L. Knott.
Oakwood, Linn County.—No.—[W. E. McIntyre.
Olathe, Johnson County.—No.—[E. P. Diehl.
Osborne City, Osborne County.—None remained.—[M. Mohler.
Osage Mission, Neosho County.—All left.
Oswego, Labette County.—No. None remained.—[T. B. Abbott.
Oskaloosa, Jefferson County.—A very few remained. I did not notice any ovipositing.
Ottawa, Franklin County.—None remained.—[H. J. Smith.
Oxford, Sumner County.—A few locusts remained after the departure of those hatched here, but there was a new feature with regard to the departure. Heretofore they have left as they came, in swarms, but this year they gradually left, and I think a month was occupied in their departure. We had extremely wet weather during May, and they were forced to leave. So far as my knowledge extends there have been no eggs deposited since a year ago this fall.—[A. Gridley, jr.
Parsons, Labette County.—None remained; no eggs laid. Very few; no.—[Angell Mathewson.
Peabody, Marion County.—A few remained all summer, but none deposited eggs.
Riley, Riley County.—None remained.
Salina, Saline County.—No; all left about the 1st of July. None remained. None remained.—[S. J. Gilmore.
Seneca, Nemaha County.—Very few; have heard that a few have been seen ovipositing, but am of the opinion that very little was done in that way.—[G. W. Johnson.
South Center, Smith County.—All left.
Tabor, Clay County.—Very few remained; no eggs laid.—[J. W. Bagby.
Fredonia, Wilson County.—Within the scope of my observation, few, if any, got wings, but died or vanished prior to making any deposits.—[S. C. Carley.
Uniontown, Bourbon County.—Few or none remained here after their maturity; no eggs laid this fall that I have seen or heard of.—[George Wier.
Valley Falls, Jefferson County.—None remained in this county; no eggs laid this fall.
Wichita, Sedgwick County.—No, all left.—[Levi Branson.
Wilmington, Wabaunsee County.—Few or none remained.
Winfield, Cowley County.—Yes, but all died.—[Wirt W. Walton.
Yates Center, Woodson County.—All left after acquiring wings.—[J. Powell.

MISSOURI.

Carthage, Jasper County.—They did not.—[J. Tilden.
Defiance, Worth County.—A few.
Forest City, Holt County.—No 'hoppers remained with us; they all left as soon as they were able to travel.—[J. D. White.
Flag Spring, Andrew County.—But few remained in our locality after the departure of those which hatched and developed; they were not noticed to lay eggs.—[J. K. White.
Greenfield, Dade County.—No.—[W. G. McDowell.
Lamar, Barton County.—A few remained, but I did not observe them laying eggs; there are a few here now, but they are doing no damage; so far as I can ascertain, they have laid no eggs.—[A. A. Dye.
Little Osage, Vernon County.—A few of the locusts remained in this locality, but none have been noticed to lay eggs.—[M. L. Modrell.
Morrisville, Polk County.—I think not; a few hatched out in isolated spots in this country in the spring, but in a short time they disappeared.—[H. C. Pritchett.
Mount Vernon, Bates County.—None remained here.—[W. S. Goodman.

Oregon, Holt County.—Some few still remain here; have not observed any depositing eggs. None; no.—[C. L. Irvine.

Pickering, Nodaway County.—A large number remained after the main body had left, but I have not observed them to lay any eggs.—[M. B. W. Harman.

Rochester, Andrew County.—No.—[J. Kimbertin.

Reeds, Jasper County.—No.—[J. M. Thornburg.

Rock Port, Atchison County.—A few remained after the departure of the main swarms; I do not think any eggs were deposited by them.—[John D. Dopf.

Sarcoxie, Jasper County.—A few have been here all the summer, but very few have been noticed laying. No.—[E. D. Barton.

MINNESOTA.

Jamesville, Waseca County.—None remained.—[J. J. Headley.

Luverne, Rock County.—None remained of any consequence, but occasionally detachments of swarms alighted for a brief period to feed, and then departed. No eggs laid; but very few coupling.—[H. Brockway.

Minneapolis, Douglas County.—None.—[R. J. Mendenhall.

NEBRASKA.

Omaha, Douglas County.—There was no general flight, and none were known to lay eggs. A very few locusts remained after the departure of those which hatched in this vicinity, but they seemed to have very little vitality. They did not lay eggs.—[Ex-Gov. Alv. Saunders.

Patron, Butler County.—None remained.—[J. Tannahill.

Plattsmouth, Cass County.—None remained; no eggs deposited.—[D. H. Wheeler.

Pleasant Hill, Saline County.—None remained.—[E. S. Abbott.

Salem, Richardson County.—Not in 1877; but in 1875 a limited number remained and deposited eggs. There were some remained till fall, I think, but never noticed any of them to lay any eggs; have not been able to find any eggs, as yet, this fall.—[B. F. Miles.

Amazon, Franklin County.—Some remained. No eggs laid.—[H. O. Hendricks.

Brownville, Nemaha County.—A few remained all the season. Have seen a few scattering ones to-day (October 27). None have laid eggs, so far as I know.—[Rob. W. Furnas.

Dewitt, Saline County.—None remained that I noticed. No eggs laid this season.—[W. F. Ware.

Genoa, Platte County.—I am not aware that any of the locusts which hatched here last spring remained, though I think a few left by passing swarms spent some time with us. I saw no eggs laid.

Hendricks, Otoe County.—A few, and but a very few, commenced to lay eggs, but suddenly ceased.

Johnson, Nemaha County.—No.—[J. B. Johnson.

Nebo, Platte County.—None remained or returned.—[John Wise.

Lincoln, Dodge County.—No. None remained.—[Silas Garber.

TEXAS.

Austin, Travis County.—None, or, if any, an occasional one that disappeared, probably picked up by birds; I don't think any remained in this section of the country through the season; they went North, to a grasshopper.—[V. O. King.

Bastrop, Bastrop County.—None remained.—[James Moore.

Black Jack Spring, Fayette County.—No.—[J. C. Melcher.

Calvert, Robertson County.—Not a locust left remaining in the whole county.—T. J. Moulton, jr.

Dallas, Dallas County.—No. None remained. None remained.—[J. Boll.

Denison, Grayson County.—No. All left very early in the season. I do not think they laid any eggs. No. The locusts all left at once.—[T. V. Munson.

Headsville, Robinson County.—None remained after the general flight north.

Helotes, Bexar County.—None remained, hence no eggs were laid.—[H. Brous.

Houston, Harris County.—In answer to your 1st, I would state that, so far as I know, that all took their departure northward as soon as they were large enough to fly, very few, if any, remaining, and I have heard of no deposits of eggs.—[A. B. Small.

Plano, Collins County.—A few remained, but no eggs laid.—[H. C. Overacker.

APPENDIX XV.

MOVEMENTS OF THE YOUNG LOCUSTS.

[Answers to question 15, circular No. 1: The prevailing direction in which the young insects traveled, and any other facts in relation to the marching of the young.]

IOWA.

Spirit Lake, Dickinson County.—Young 'hoppers seem to move northward.—[Mosher

Mount Hope, Sac County.—They staid where they hatched until they acquired wings.—[Holmes.

Lake City, Calhoun County.—In 1874 the young 'hoppers seemed to travel north.—[Jack.

Alta, Buena Vista County.—No particular direction; mostly with the prevailing winds.—[Thompson.

Fort Dodge, Webster County.—Seems to be northward.—[Mrs. Swain.

Dakota City, Humboldt County.—Mostly toward the north and northwest.—[Adams.

Estherville, Emmett County.—In every direction, apparently hunting for food.—[Jarvis.

Alta, Buena Vista County.—In the pupa state they have traveled in a southerly direction from 11 a. m. to 6 p. m.—[Crowell.

Pringhar, O'Brien County.—They travel in every direction in search of food.—[Longshore.

Sidney, Fremont County.—The prevailing direction of travel is nearly east, perhaps from 5° to 10° north; this course I have decided upon from examining different schools in different localities, and at various times.—[G. V. Swearengen.

Tabor, Fremont County.—The locusts commenced flying due east this afternoon; yesterday afternoon flying southeast; pupæ, when traveling at all, move in a south and east direction, generally following the roads.—[J. E. Todd.

NEBRASKA.

Plattsmouth, Cass County.—Toward food.—[Child.

Pleasant Hill, Saline County.—Their line of travel depends on the surface of the ground and proximity to crops.—[Abbott.

Arago, Richardson County.—Northeast and north.—[Gerdes.

Hebron, Thayer County.—Travel but little; with the wind.—[J. W. Fitzpatrick.

Niobrara, Knox County.—South.—[Hulliban.

Farmers Valley, Hamilton County.—No particular direction.—[Vosburgh.

Sunlight, Cass County.—They march for some field of grain and stay till fledged, if good picking.—[Babbitt.

Ponca, Dixon County.—Nearly always to the north or northwest.—[Rockwell.

Plattsmouth, Cass County.—Southeast.—[Wheeler.

Genoa, Platte County.—Northeast.—[Truman.

Burr Oak, Otoe County.—Northwest direction.—[Davidson.

Friend, Saline County.—The young insects do not travel, except in search of food; they will not average more than three feet in 24 hours.—[Whitcombe.

Salem, Richardson County.—No particular direction.

Hooper, Dodge County.—Those hatched here invariably go northwest.—[Eisley.

Tecumseh, Johnson County.—All directions; they go to the nearest barley or wheat field.—[Holmes.

Nebo, Platte County.—According to promise, I give you a few observations of my own in regard to the Rocky Mountain locusts within the limits of Circular No. 2. The locusts are now about three-quarters of an inch long, and grow very slowly, on account, I think, of the continued cold, wet weather. They have done no perceptible harm, except in small spots here and there, for the last six weeks. For the past few days, in clear weather, of which we have but little at a time, they move in a northwest course, leaving their hatching-ground for the prairie or adjoining pieces of grain. To-day we have a brisk northwest wind and cold alternate showers and sunshine, yet they are striving to march on, the wind often whirling them back many feet; but, like the gritty bug that they are, they up and try it again. Some of my neighbors dug deep and wide ditches, but they prove of no avail; those that do not make a clean jump climb up some other way—the same as many persons try to get into the sheepfold.

Besides this, they (the 'hoppers) seem to know that there are obstructions in the way, and many make an oblique march and flank the enemy. I observe the same maneuver where there is water in front of the marching column, which has been the case frequently the past six weeks. Some persons claim that many are dying from some unknown cause, but I have failed to discover the fact to my satisfaction. It is a truth, however, that the birds and devouring insects, such as spiders, bugs, &c., have feasted on them to a great extent, from the fact that the cold and continued wet weather has kept them in a numb and helpless state the most of the time since their first appearance. I feel confident that if the weather had been warm and dry, as it usually is in this country at this time of year, our crops would have been destroyed to a great extent ere this. I shall in a few days send you another lot of the advanced growth of 'hoppers so you can see what progress they have made. I would state that the nature of the soil where ditches were made is a stiff, clay soil, on what we call rolling or bluff prairie-land. So far, crops that have suffered most are wheat, and this only a small per cent. Oats, barley, rye, and corn a mere trifle. Crops of all kinds look very promising, taking out the few pieces of grasshopper wheat, with the exception of corn; that is backward from wet and cold, otherwise good.—[John Wise.

DAKOTA.

Saybrook, Clay County.—North.—[Hall.

(*Unknown.*)—Generally south and southeast; occasionally in the opposite direction.

Sioux Falls, Minnehaha County.—Do not appear to travel in any particular direction.—[Everett.

MINNESOTA.

Carver, Carver County.—Northwest, but west and north along paths and public highways; brush and timber will change their course.—[Dunn.

New Auburn, Sibley County.—To north and northwest.—[Clevinger.

Norwood, Carver County.—Mostly northwest.—[Tiffany.

Worthington, Nobles County.—No particular direction until fully winged, then always south.—[Churchill.

Excelsior, Hennepin County.—The young insects move in every direction from their hatching-ground.—[Powers.

Lake Park, Becker County.—Mostly south and southeast.—[Holton.

Magnolia, Rock County.—Generally travel with the wind.

Lake Eunice, Becker County.—In every direction before acquiring wings; after, southeast.—[McLelland.

Saint Peter, Nicollet County —In 1875, northwest.—[Arnold.

Glenwood, Pope County.—In every direction; mostly with the wind.—[Campbell.

Mankato, Blue Earth County.—No particular direction. I have known swarms in the same vicinity to travel in opposite directions.—[John C. Wise.

Marshall, Lyon County.—Young locusts only move about to obtain food. They will come to a wheat field from the prairie.—[Weymouth.

Holmes City, Douglas County.—Southeast.—[Blackwell.

Detroit, Becker County.—North.—[Wood.

Alden, Freeborn County.—No preferred direction.—[Cross.

Becker, Sherburne County.—South of east.—[Wagner.

Burnhamville, Todd County.—The young insects generally travel in the direction of the wind, but when once on their way a change in the direction of the wind would not induce them to change their course. They like to follow roads and paths and seem more inclined to travel shortly before they enter the winged state than at any other stage.—[Rhoda.

(*Unknown*).—In this locality, north.

Seward, Nobles County.—Always with the wind.—[Terry.

Madelia, Watonwan County.—June 16, 1877, southwest.—[Sylvester.

Norseland, Nicollet County.—It seems to me that they generally prefer to travel against the wind, because I have observed that when the wind is from a northerly direction they go that way, and when it is from the south they turn in that direction; but when they feel the scent of a wheat field they care neither for wind nor direction, all seem instinctively to turn toward it.—[John Webster.

Dassel, Meeker County.—Invariably with the wind.—[Maxon.

Worthington, Nobles County.—Mostly west or south in droves.—[McDowell.

Collins, McLeod County.—When the wind changes the young 'hoppers seem to hop against it for the period of 24 hours, and then in every direction until another change takes place.—[Canfield.

Banks, Faribault County.—Southeast.—[Payne.

Golden Gate, Brown County.—They traveled in all directions.—[Letford.

Kerkhoven, Swift County.—The young 'hoppers, before they had wings, seemed to move mostly northwest.—[Jacobson.

Willmar, Kandiyohi County.—They seem to move southeast when very young.—[Haly.

Sibley, Sibley County.—General direction north, although it has varied in different localities at different times.—[Woodbury.

Vicksburg, Renville County.—They are not governed by the wind, but travel toward the fields.—[Mrs. Rich.

Worthington, Nobles County.—West and south.

Otto, Pope County.—In all directions.—[Hoffman.

Alexandria, Douglas County.—In any direction, in quest of food.—[Aaker.

La Verne, Rock County.—Southeasterly direction. I am inclined to believe that they do not make a continuous march, but march a few days, then have a season of rest and feeding. I have discovered that they shed their coat or outer covering, I should think, at about four weeks old, and during the time of shedding, and for a few days after, they are quite stupid; so much so, that they can be easily caught with the hand. Inclosed I send you some of their skins. Also, at the time of taking wings, they shed their coat again. Before shedding, there are to be seen on their shoulders elevations resembling black buttons, in which the wings are folded, and immediately after shedding unfold and take their natural shape; and in three days they are ready to fly. Immediately after shedding they are very stupid—can neither fly nor jump—and appear quite soft and clumsy. When they take their wings I will send some specimens if you wish.—[H. Brockway.

MISCELLANEOUS.

Ottawa, Kansas.—Northwest.—[A. Willis.

Atchis n, Kansas.—In the direction where there was something good for them to eat.—[E. Snyder.

Tonganoxie, Leavenworth County, Kansas.—Young locusts traveled backward, forward, and criss-cross.—[H. V. Needham.

Tabor, Clay County, Kansas.—Insects seem to search for protected places.—[I. W. Ragby.

Calvert, Robertson County, Texas.—They traveled in shoals, in all directions. For five miles' travel you could meet them going to various points of the compass the same day.—[D. Parker.] Alternately, north and south, or northeast and southwest. They seemed to march in swarms, and in portions of the country went to all points of the compass.—[W. L. Coleman.

Austin, Travis County, Texas.—The young grasshoppers commenced to travel early in the season, and went in a northwest course generally. Some days they would go north. They commenced to travel as soon as they could hop about in the fields. In the timber or brush they remained some longer; did not travel so fast. I think the cause of it was, they were not disturbed as they were in the fields. There were no means of any kind used in this section to protect crops from the young locust.—[John Secrist.

Diamond City, Jasper County, Missouri.—South-southwest from ten in the forenoon till sundown, after which they began to feed. The unfledged locusts would be all over a field one day, and the next would be gone, and no one could tell where or when they went.—[Wm. G. L. Craig.

Smithfield, Cache County, Utah.—The young insect generally travels south and west, unless headed by streams or insurmountable obstacles, such as barren or marshy lands.—[James S. Cantwell, P. M.

APPENDIX XVI.

TIME OF YEAR WHEN THE INSECTS GET FULL WINGS.

[Answers to question 9, circular No. 1. Date at which the first insect acquired full wings.]

IOWA.

Dakota City, Humboldt County.—July 15.—[Adams.
Primghar, O'Brien County.—May 15, 1877.—[Longshore.
Lake City, Calhoun County.—About July 1, in former years.—[Jack.
Mount Hope, Sac County.—June 25, 1877.—[Holmes.
Alta, Buena Vista County.—June 20.—[Crowell.

NEBRASKA.

Tecumseh, Johnson County.—June 20 to 25.—[Holmes.
Plattsmouth, Cass County.—June 5, 1875; a few June 6, 1877.—[Child
Sunlight, Cass County.—About June 3, 1875.—[Babbitt.
Pleasant Hill, Saline County.—About June 1, 1875.—[Abbott.
Ponca, Dixon County.—Insects acquired full wings when about six weeks old.—[Rockwell.
Arago, Richardson County.—June 18.—[Gerdes.
Hooper, Dodge County.—About 50 days after hatching, June 25 to 30.—[Eisley.
Friend, Saline County.—About June 28.—[Whitcombe.
(*Unknown*), *Richardson County.*—About June 28.

MINNESOTA.

Holmes City, Douglas County.—June 25.—[Blackwell.
Grafton, Sibley County.—June 20, 1877.—[Gardner.
Burnhamville, Todd County.—June 22.—[Rhoda.
Alexandria, Douglas County.—The latter end of June.—[Abercrombie.
Excelsior, Hennepin County.—July 1.—[Powers.
Dassel, Meeker County.—June 20, a very few.—[Maxon.
Seward, Nobles County.—July 8, 1876.—[Terry.
(*Unknown*).—1st to 10th of July.
South Bend, Blue Earth County.—Last of June.—[Davis.
Carver, Carver County.—June 12, a few.—[Dunn.
New Auburn, Sibley County.—June 20.—[Clevinger.
Albert Lea, Freeborn County.—May 15.—[Johnson.
Norwood, Carver County.—June 15.—[Tiffany.
Banks, Fairibault County.—July 10.—[Payne.
Pipe Stone, Pipe Stone County.—July 11.—[Sweet.
Jackson, Jackson County.—July 1 to 10.—[Chamberlain.
Raymond, Stearns County.—July 6.—[Raymond.
Vicksburg, Renville County.—June 25 to 27.—[Rich.
Oak Lake, Becker County.—About June 30.
Lake Eunice, Becker County.—July 4.—[McClelland.
La Verne, Rock County.—First insects acquired wings June 25. Commenced leaving July 1.—[H. Brockway.
Vicksburg, Renville County.—June 25 to June 27.—[Hale.
Oak Lake, Becker County.—About June 30.—[McGrew.

KANSAS.

Claytonville, Brown County.—It is difficult to tell with certainty just when the locusts commenced their fledging here, as others from the south have been occasionally dropping for a month past every time the wind has been from that direction. About the beginning of this month, however, I observed the larger ones gathered themselves together and seemed dull and listless for a day or two, then crawled up sticks and straws, and pulled themselves into another stage of their existence.—[H. M. Robertson.
Mount Pleasant, Atchison County.—About June 15.—[F. M. Dougan.

COLORADO.

La Porte, Larimer County.—Latter part of June.—[E. N. Garbutt.

MISSOURI.

Diamond City, Jasper County.—June 20.—[William G. L. Craig.

TEXAS.

Calvert, Robertson County.—April 20. It was full three months from the time they commenced hatching here before any of them had wings.—[W. L. Coleman.] April 20.—[D. Parker.

Austin, Travis County.—Some, but not many, acquired wings the 10th of April.—[John H. Secrist.

NEW MEXICO.

Socorro, Socorro County.—July 1.—[George May.

UTAH.

Smithfield, Cache County.—From 1st to 5th of June.—[James S. Cantwell, P. M.

APPENDIX XVII.

HABITS AT NIGHT.

[Answers to question 23, circular 1, and 30, in Mr. Thomas's additional questions: State all you know about the habits of the young or full-grown insects during the night, and especially whether you have ever known them to march or continue to fly after the sun is down, and if so, how long into the night.]

IOWA.

Alta, Buena Vista County.—Neither fly nor eat, but sit still where they are when night comes.—[Thompson.] The very young get under clods or anything to keep warm. The older prefer to ascend anything to roost. Do not march nor fly, but destroy where they roost.—[Crowell.

Lake City, Calhoun County.—They will gather on trees, fences, weeds, cornstalks, &c., to roost. Do not eat nor travel at night.—[Jack.

Primghar, O'Brien County.—Young insects seem not to eat at night, but seek protection from wind by getting under clods and grass. The grown insects eat a little at night.—[Longshore.

Sioux City, Woodbury County.—The young 'hoppers are generally dormant at night. As evening approaches they will climb upon straw stubble, fences, small trees, or any other substance that is high and dry, and remain there until morning. The old 'hoppers seem to work about the same, unless in flight. It is generally thought that they do not light at night unless the wind becomes unfavorable.—[Skinner.

DAKOTA.

Saybrook, Clay County.—Appear to sit still behind the sheltery side of anything, to keep warm. Sit still; don't eat.—[Hall.

Olivet, Hutchinson County.—They surely fly at night during their passage, as they are seen every fair day during summer on the wing, but do not light at night.—[Jones.

Sioux Falls, Minnehaha County.—Young 'hoppers will go five or six rods to get into straw or high grass for the night.—[Everett.

Milltown, Armstrong County.—Think they lie still at night.—[Taylor.

Wahpeton, Richland County.—Neither fly, march, nor eat at night. Congregate in piles two or more inches deep, or on small shrubs and weeds.—[Smith.

Walhalla, Pembina County.—Locusts neither fly, march, nor eat at night.—[Miss Mayer.

NEBRASKA.

Farmers Valley, Hamilton County.—At night and in rainy weather they go to high grass or stalks for shelter. I had a field of corn in 1874 that was standing and not seriously damaged when night commenced. The next morning it was only cornstalks, leaves and ears having been eaten.—[J. Vosburg.

Plattsmouth, Cass County.—The young cluster under leaves, clods, roots, &c., not at night, but in rain and cold weather; do not eat under such circumstances. The grown remain perched on trees, bushes, &c. When on the wing, I am much inclined to think they fly all night.—[Child.

Sunlight, Cass County.—Grown ones fly up to roost; young crawl up on stubble, weeds, &c.—[Babbit.

Steele City, Jefferson County.—They rest during the night on bushes, cornstalks, &c.—[Gantt.

Arago, Richardson County.—They crawl up to the top of fences, bushes, weeds, and grain.—[Gerdes.

Grand Island, Hall County.—Toward evening the young 'hoppers climb bushes, poles, sticks, small trees, and on wet and cold days they seek shelter under anything that will hold them.—[Stolley.

Hooper, Dodge County.—Never move at night unless disturbed.—[Eisley.

Pleasant Hill, Saline County.—Young insects quiet at night. The old ones collect on trees and shrubs, sometimes in sufficient numbers to bend the trees.—[Abbott.

Chapman, Merrick County.—They feed mostly on cloudy days, in the evenings and warm nights. They crawl upon all kinds of vegetation of an evening and stay until the hot sun of the next day, then they seek the shade.—[Cox.

Fremont, Dodge County.—Do not fly but sometimes eat at night. If flying they will light before sunset.—[Blanchard.

Ponca, Dixon County.—The young do not eat at night but crouch down under some grass or bush, or around a lump of dirt. The old ones eat all night as well as all day to my certain knowledge.—[James Rockwill.

Friend, Saline County.—The young and growing remain under straw, earth, hay, old grass, and fallen weeds, during the night.—[Whitcomb.

Niobrara, Knox County.—They remain quiet until morning.—[Hulliban.

MINNESOTA.

Avon, Stearns County.—Think the young do most damage nights.—[Brakefield.

Golden Gate, Brown County.—They climb on plants, trees, and fences (in fact roost).—[Letford.

Banks, Faribault County.—Get in dry places; sit dormant.—[Payne.

Le Sueur, Le Sueur County.—They gather in clusters during the night, either on the ground or vegetation.—[Chapman.

Willmar, Kandiyohi County.—The young and the old insects seem to have about the same habits; they get up on the grain in the evening, and, I suppose, feed during the night. I do not think they march much during the night-time.—[Haly.

Detroit, Becker County.—The old stop at night to feed; the young do the most mischief at night.—[McLelland.

South Bend, Blue Earth County.—Young on houses and fences, as general rule.—[Davis.

Cooleyville, Steele County.—They go to roost early in the evening, in the most sheltered places that they can find.—[Clark.

Worthington, Nobles County.—Young 'hoppers, as the sun goes down, leave the grass and go down to the ground, crawling under lumps of dirt and into cracks in the ground. They are hard to be found during a cold rain, but the sun is never too hot for them; even the focus of a sun-glass will not kill a full-grown 'hopper. Strange as it may seem, it is nevertheless true. This is from my own experimental knowledge at different times, holding the glass above the head so as to get a direct focus; which, if the same focus was placed on paper, and the glass moved slowly along, it would burn a streak through the paper as fast as it was moved. Fifteen minutes of such a trial has proved insufficient to destroy the life of his 'hoppership.—[Churchill.

Seward, Nobles County.—Young always roost in grass or furrows. Winged 'hoppers always roost on grain, tall grass, sides (*i. e.*, walls) of houses, barns, fences, &c.—[Terry.

Windom, Cottonwood County.—Both seem to roost on fences, weeds, trees, and anything they can get upon, except when quite young, when they appear to hide under chunks of dirt. I have been told by persons who claim to have seen them that they sometimes fly during moonlight nights; but I am doubtful on the subject. My experience has been that they never fly or march after sundown, and seldom ever fly before nine o'clock in the morning, and usually light about noon; but have known them to keep coming down till nearly sundown. Think they do not eat much after sunset.—[Huntington.

Becker, Sherburne County.—Certainly eat, but don't travel.—[Wagner.

Tenhassen, Martin County.—They seem to lie in groups on fences and houses, in sheltered spots on the ground. Don't march nor eat.—[Merry.

Madelia, Watonwan County.—The young seek shelter from cold in dry straw or grass; but in warm nights they crawl up on all surrounding objects, such as fences, old weeds, and upon growing crops and grass.—[Sylvester.

New Auburn, Sibley County.—They gather on grass, grain, high weeds, fences, &c., about one to two hours before sundown, and remain thus until the dews are off in the mornings. Do not eat nights or very cold days.—[Clevinger.

Dewald, Nobles County.—As far as my observations extend they do not eat nor fly. At night they climb on weeds, grass, hay, or grain, &c., so as to get sheltered apparently from heavy dews, and so remain till sunrise. We often take advantage of that habit of theirs in this way: Spread hay or straw on the ground two or three inches thick, or so, an hour or more before sunset. They will get on and under the straw in great numbers before dark. Then fire all round as soon as it is dark. Morning and evening seem to be their feeding times. I don't think they eat either at midday or night; but I may be mistaken in that respect.—[Bates.

Norseland, Nicollet County.—At night both young and grown insects sit still; if they are near any fence, growths, or anything elevated from the ground they will crawl upon it; if they are on bare ground they will go in clusters to remain all night.—[Webster.

Dassel, Meeker County.—Young 'hoppers congregate at sunset in groups or bunches at the foot of fence-posts, under sides of logs, at roots of stumps, by the side of buildings, &c. During night remain quiet. When larger they climb upon fences, buildings, trunks of trees, &c. The full-grown 'hoppers also climb the stack of grain, small bushes, fences, buildings, &c. During night, at other times, they remain quiet. I have known them to eat the weatherboards on my house in one night, so that it looked like newly-planed lumber (it was bass-wood siding); also to eat the leaves of trees during night, and other nights the bushes would remain unharmed, although so loaded with hoppers that the limbs would nearly break with their weight.—[Maxson.

Clear Lake, Sherburne County.—They roost on the fences and trees; do not think they eat during the night.—[Frye.

Alden, Freeborn County.—Remain on the ground unless disturbed. Eat on what they light on.—[Cross.

Worthington, Nobles County.—The young at night, when warm and pleasant weather, climb up on grass, weeds, hay, stubble, or straw; but if cold or wet they crawl in the ground, under clods, or in cracks or holes. The winged locusts mostly alight at night, but sometimes fly all night with a favorable wind.—[McDowell.

Heron Lake, Jackson County.—After they are one-half grown they will swarm upon fences and buildings as bees will hang on the outside of the hive; or where they cannot find such places they will climb upon the tallest weeds or grain and appear sleepy; and I do not think they eat any during the night.—[Edwards.

Watab, Benton County.—The old ones climb up on bushes or the sides of buildings when they are handy; if not handy they sit on the ground and eat; the young ones do the same.—[Gilman.

Cosmos, Meeker County.—I think they never march or fly except they are already on the wing. Do not think the young ones eat at night; gather on stalks, &c.—[J. N. McDonald.

Saint Peter, Nicollet County.—They rest on the bare ground, fences, bushes, or tall weeds.—[Arnold.

Holmes City, Douglas County—Eat all night if they are on anything they like; never march.—[Blackwell.

Glenwood, Pope County.—Roost on stalks, &c.; if cold, seek shelter low.—[Campbell.

Luverne, Rock County.—Old ones remain quiet. I have often been to the grain-field, between sundown and dark, and could hear the 'hoppers dropping from the grain to the ground; they make a noise like a heavy shower of rain.—[H. Brockway.

Norwood, Carver County.—Remain during the night.—[Tiffany.

Mapleton, Blue Earth County.—Remain on fences; don't fly, &c.—[Williams.

Sibley, Sibley County.—Young climb on the grass or seek some sheltered spot, &c. I have seen long grass in the meadows at sunset look as black as hazel brush, fairly loaded down with young 'hoppers.—[Woodbury.

Blue Earth City, Faribault County.—Climb upon grass, weeds, &c. Seem to feed freely before leaving.—[Bonwell.

Leonthrop, Chippewa County.—They eat.—[Rollerson.

Orr, Jackson County.—The young always seek some place for cover during the night. Never knew them to travel or eat during the night. Never knew grown insects to fly during the night, but think they usually eat at night.—[Palmer.

Collins, McLeod County.—Toward night they climb on fences, grain, weeds; in fact anything in their reach. They feed mostly after 5 p. m.; sometimes all night, and quite early in the morning.—[Canfield.

West Newton, Nicollet County.—They climb up on the straws and on the small trees, and, as I have heard, they do eat.—[Kyllander.

Marshall, Lyon County.—If they fly nights no one knows it. If they go to roost they are in the same spot next morning, and do not move till the dew is all off.—[Weymouth.

Saint Cloud, Stearns County.—When very young and nights rather cool they crawl under small lumps of dirt, or old grass, or leaves, or bits of chips, &c. As they get older they select the warmest bare ground, or old straw, leaves, &c., but do not burrow under; then afterward they select bushes, tall grass, wheat, or grain of any kind, or in fact almost any vegetable that will keep them from the ground, crawl on the fences, old boards, logs, &c. This more markedly when heavy dews prevail. I believe the young and the old sometimes eat in the night, when there is no dew and the night proves warm; do not think they fly or march much after night.—[J. I. Salter.

MISCELLANEOUS.

I have never known them to fly after sundown, nor to march after that time. They generally gather on grass, grain, or bushes in the evening, and remain inactive during the night. The eggs are generally deposited in patches, and, after hatching, the 'hoppers move together in some direction, east, west, north, or south, eating as they go, until they meet with some obstacle, water, or trench, when they will stop for days, finally turning and moving off at right-angles from their former course. I have known a batch in one field to be moving north, while a batch in a neighboring field would be going south. When they get wings, so that they can fly, they will leave grain or garden with the first favorable wind. They never move in flights without a fair wind, and I have seen but one flight going west in the past ten years.—[E. N. Garbutt, La Porte, Larimer County, Colorado.

The crops which have suffered most in this section are wheat and barley; those that have suffered least are corn and oats; that is, from the young 'hoppers of this season. The prevailing direction of travel has been south. I have never known them to continue their flight at night. I have not known of their coming or leaving in the night, which they probably would have done, did they continue their flights after dark, for

in this country the wind changes mostly at night, and in case of their flying over at night a change of wind would cause them to alight, and we should find them in the early morning, where there was none the previous evening.—[N. J. Newell, Athol, Lyon County, Iowa.

Do not think they fly during the night. So far as I have observed, swarms passing over commence alighting about 5 o'clock p. m., and remain during the night.—[H. Brockway, Luverne, Rock County, Minnesota.

When on green trees and shrubs they feed very considerably during the night, stripping trees of their leaves, and also gnawing the bark so as to girdle small tender barked trees, and giving tougher bark a ragged uneven surface as it grows after. I have never known locusts, either large or small, to move nights. They are clumsy, and not inclined to move when the thermometer is below 60°. I do not think the eggs develope at all with the thermometer below 60°, and perhaps 65°. I should like to know at what point of warmth the eggs develop.—[C. C. Perkins, Oswego, Kans.

Never saw them travel at night. As long as dew or rain lasted they huddled together on tall weeds or plants, grape-vines, small trees, poles, &c.—[Herman Jaeger, Neosho, Mo.

APPENDIX XVIII.

RELATING TO THE EGGS.

[Answers to the following questions in circular No. 1: 3. Date when the first eggs, if any, were deposited the present year. 4. Date when the eggs were most numerously hatching the present year. 5. Date when the eggs were most numerously hatching in previous years. 6. Proportion of eggs that failed to hatch the present year and probable causes of such failure. 7. Nature of the soil and situations in which the eggs were most largely deposited. 8. Nature of the soil and situations in which the young were most numerously hatched.]

COLORADO.

La Porte, Larimer County.—3. No eggs deposited this year. 4. From the middle of May to the middle of June. 5. During May. 6. One-fourth on account of parasites. 7. Gravel-patches, meadows, and pasture, whether heavy clay, sand, or gravel. 8. Gravel places first; clay and sand next.—[E. N. Garbutt.

Greeley.—4. In the middle of May they hatched out in considerable numbers in some spots, and were all around my wheat, but by keeping the water running in the ditches all the time I have been able to head them off, and then we had a heavy and cold snow-storm. 6. From what I hear there was a good many all formed and just ready to come out, and would have hatched out right, but the snow-storm reduced them. 7. Sandy and dry knoll. 8. Sandy knolls and hill-sides with a southern exposure.—[H. Smith.

DAKOTA.

Olivet, Hutchinson County.—4. April and May. 7. Bare ground. 8. Black, sandy mold; high, dry places.—[Jones.

Bonhomme, Bonhomme County.—4. Fifth to tenth of May. 6. About one-fourth failed; cause, warm weather in midwinter followed by extreme cold. 7. Light, sandy soil. 8. Light, sandy soil.—[Bradford.

Walpeton, Richland County.—4. Commenced May 10; most numerous by May 25, continuing until after June 27, 1877. 6. Few failed; cause, small worm and small bug. 7. Most thoroughly packed sandy soil. 8. Most thoroughly packed sandy soil.—[Smith.

Saybrook, Clay County.—4. About May 15. 7. South side of side hills and in gravelly or sandy ground.—[Hall.

Milltown, Armstrong County.—4. About May 15. 6. Nine-tenths; cause, wet weather. Early spring followed by freezing. 7. High dry soil; new plowing and breaking. 8. On grass lands.—[Taylor.

Sioux Falls, Minnehaha County.—4. Nearly all hatched. (Date of letter May 26, 1877.) The heavy rains retarding the hatching. 6. About half. 7. On last year's breaking and sandy knolls, and other places where the ground was not shaded by vegetation. 8. Appears to be no difference, except that the hatch is a week later in low places.—[Everett.

Sioux Falls, Lincoln County.—4. April 20 to May 15. About May 5 most numerous. 6. Some destroyed by birds and some by parasites. 7. Sandy soil; new breaking.—[Jacobs.

Sioux Falls, Minnehaha County.—4. In February and in May (5 to 18). 6. About two-thirds failed; alternate cold and warm weather; parasites. 8. Breakings; sandy soils and south side of hills. 9. About two weeks after hatching.—[Unknown.

Jamestown, Stutsman County.—4. Few from May 10 to 28. 5. May 12 to 20, 1874. 7. Sandy, high, rolling prairie. 8. Ditto.—[Moore.

Sioux Falls, Minnehaha County.—4. From 10 to 18 of May. 6. Nearly all hatched. 7. On last year's breaking almost exclusively. 8. Have hatched in all situations, but those on low ground were the last to hatch.—[Clark.

Dell Rapids, Minnehaha County.—7. On new breaking. 8. Undisturbed sod.—[Hill.

IOWA.

Alta, Buena Vista County.—6. One-third failed; cause, deep plowing and harrowing in the fall and in February. 7. Breakings, roads, gardens, and sandy rolls.—[Thompson.

Fort Dodge, Webster County.—4. April 14 to May 21, 1877. 7. Sandy loam and south side of knolls. 8. Sunny situations.—[Mrs. Swain.

Alta, Buena Vista County.—4. 1st to 10th of May, 1877. 6. 50 per cent.; cause, red parasite; wire worm; deep plowing; snow-birds;. 7. Dry, black loam breaking, south east slope; sandy knolls. 8. Same.—[Crowell.

Estherville, Emmett County.—4. May 10 to 25, 1877. 5. May 1 to 25, 1874. 6. Red parasite destroyed a few.—[Jarvis.

Shelby.—4. April 15 to May 2.—[W. H. Brown.

Dakota, Humboldt County.—4. May 20 to June 15, 1877. 6. About two-thirds failed. 7. Sandy soil; exposed situations; road-beds. 8. Sandy hill-sides; breakings.—[Adams.

Pringhar, O'Brien County.—4. Middle of April to June 1, 1877. 6. One in 100 failed; cause, red bug. 7. Breaking; black loam. 8. South exposure; sandy soil.—[Longshore.

Lake City, Calhoun County.—4. April 23 to 26, 1877. 5. May 1, previous years. 6. Fifty per cent. failed; wet, cold condition of ground. 7. Dry sandy, clear road-sides; breakings. 8. High, dry, warm situations.—[Jack.

Mount Hope, Sac County.—4. May 20, 1877. 6. About one-third failed. 7. Breakings; dry soil. 8. Dry soil. New ground.—[Holmes.

Sioux City, Woodbury County.—4. April to May 7, 1877. 6. Small proportion hatched; cause, warm winter, then cold; fall plowing; red-bug. 7. New breakings, fallow ground; large; road-sides. 8. High, dry places.—[Skinner.

Hazard, Cherokee County.—4. The first week in May. 7. In sod-lanes broken last season.—[Pierce.

Chickasaw, Chickasaw County.—7. It seems to not make much difference as regards soil for depositing eggs. It is anywhere where they happen to be when the time for depositing arrives. I think, however, if any particular kind of soil has an advantage it is a sandy soil.—H. H. Hobbs.

Little Sioux, Harrison County.—3. First eggs deposited August 11, 1876. 4. April 18, 1877. (*Remark:* Many eggs were hatched during a warm spell in March, but mostly perished by the wet that immediately followed.) 5. From May 1 to May 15. 6. Difficult to answer, but will hazard the assertion of one-third; causes, violent rains in the fall of 1876 causing them to be uncovered, and cold and wet this spring. 7. Tight, compact earth, rather sandy, smooth bare places, as in the highways; August-plowed fields. A tremendous amount of eggs has been deposited in the timber grounds upon the Missouri River bottoms. 8. Dry, light, sandy soil of river-bottom ground, bluff grounds, and invariably on road-side.—[A. H. Gleason.

Des Moines, Polk County.—4. Eggs hatched most numerously about May 25 to June 1; commenced hatching about May 10, that is, in great numbers. 7. They were deposited most numerously on new or last season's breaking, along road-sides, railroad embankments, &c.; almost none in corn fields or stubble ground. (This was the condition of ground at the time of deposit of eggs.) 8. They hatched as deposited, no ground observed to be deleterious to the eggs.—[C. L. Watrous.

KANSAS.

Belleville, Republic County.—4. Eggs deposited in the fields where there was an exposure to sun, were the first to hatch. These commenced hatching as early as the 4th of April, 1877, but the general hatching was not until about the 14th or 15th following, and they have not all hatched yet, for the young white ones are seen occasionally just kicking off their shells; of those that hatched first I can see but few now.—[J. P. Heaton.

Argyle, Sumner County.—3. Not any. 4. April 3 to 14. 5. Latter part of May, 1875. 6. In some places 80 per cent.; in others 50 to 25; cause of such failure unknown as yet. 7. Soil sandy; in some places hard clay; in some places sheltered by timber on the creek and river. 8. Same as the above.—[Thomas Nixon.

Ottawa, Franklin County.—3. About October 1, 1876. 4. Very few hatched at all in this vicinity. 5. In 1875, from April 1 to April 10. 6. Nearly all; do not know the cause. 7. In soil moderately hard and free from weeds. 8. In creek bottoms, but I think not many there.—[A. Willis.

Coyville, Wilson County.—6. On May 2, I could not find any damaged eggs or any traces of them, or any young locusts in the localities I found them before. For the past ten days or two weeks we have had cloudy and wet weather, which may have destroyed all traces of the damaged eggs. In another location I found some that have the appearance of the egg shrunken and dried.—[O. J. Thwaites.

Mount Pleasant, Atchison County.—6. I found but very few eggs that failed to hatch; of these most, I think, were "spoiled" by exposure to the sun and air; those remaining in the "cells" failed, I think, from not being fecundated or impregnated. As there are no eggs here the present year, I do not know the proportion of failure to hatch; but I doubt if it is more than 5 per cent., judging from previous years. 7. Eggs most numerously deposited in stiff clay, early-plowed stubble (wheat or oats) land and blue-grass swards; level or southern, and eastern or western exposures seem to suit them best. The chief condition, I think, is a stiff, compact condition of the

soil, to prevent the cells from being covered too deeply by the action of frost and rain, and to guard against the efforts of small birds to get at the eggs. In the invasions of 1865–'68, there was but little blue grass here, and their favorite ground was the road-sides; but in that of 1874 the greater portion of the eggs here were deposited in the blue-grass pastures. 8. If there was one place where they hatched relatively more (to the eggs deposited) than another, I would say clay land with southern slope.—[J. M. Dougan.

Oxford.—6. Many eggs nearly ready to hatch in February were injured by cold weather in March. 7. The eggs were most largely deposited (1876) on sod-land that was turned over that summer; and when on old land, generally the harder portions were chosen, or some road or path through the fields. 8. Young most numerously hatched on new ground, and other things being equal in bottom-lands near the streams rather than on uplands.—[Ch. Gridley, jr.

Atchison, Atchison County.—4. The constant and heavy rains prevented the hatching of eggs early in the season; the most were hatched from the middle of May to 1st of June. 5. Frost to middle of May. 6. A large proportion of the eggs destroyed by parasites, the washing off of top soil by heavy rain, exposing eggs to birds, &c. 7. On high, dry, and bare places. 8. Dry south exposures.—[E. Snyder.

Tabor, Clay County.—6. Probably 5 per cent. failed; some became covered by wind and rains; others exposed eaten by wild fowls, insects, &c. 7. Sandy loam and land that had been stirred a few weeks previously.—[J. W. Bagby.

Tonganoxie, Leavenworth County.—4. Eggs most numerously hatching about the first week in May.—[H. V. Needham.

Oswego, Labette County.—4. More locusts have hatched at this point during the last twelve days (from the 14th to the 26th of May) than all previous, and I think the hatching is nearly done for this season.—[C. A. Perkins.

Lane, Franklin County.—4. The first week in June I visited a portion of our county, and was very much surprised to find that thousands of young locusts had just hatched out. A week or so after they vanished without doing any injury.—[James Hanway.

Manhattan, Riley County.—8. The 'hoppers began to hatch on the sandy bottoms about April 1, and continued to hatch on warm days, especially when the ground was soft, after rains, until after the 1st of June. On the north of the farm of one of my neighbors is a large field, on which rye was raised last year, and it was not plowed either last fall or this spring, and the 'hoppers have come from it on to his farm and done a good deal of damage. They are there now, in large numbers, from one-quarter of an inch long to full-grown.—[J. C. Wells.

Guilford, Wilson County.—4. April 27. 6. All hatched. 7. High, dry, red soil, free from weeds, where apple-seedlings had been raised.—[Geo. B. Brown.

MINNESOTA.

Mapleton, Blue Earth County.—4. June 4, 1877. 7. Sandy, rolling lands. 8. Sandy, rolling lands.—[Williams.

Janesville, Waseca County.—4. May 26 to June 3. 5. May 17 to June 3. 6. Large part failed. Cause: Cold nature of the soil; insect enemies. 7. Hardest and driest. 8. Hardest and driest.—[Headly.

Middletown, Jackson County.—4. Middle of April to May 25. 7. Solid bare ground.—[Davis.

Cosmos, Meeker County.—4. About the middle of May. 7. Driest soil. Places most open to the sun. 8. Driest soil. Places most open to the sun.—[McDonald.

Albion, Wright County.—4. Middle of May to 1st of June. 6. One-quarter failed. 8. Gardens and road-sides.—[Howard.

Lac-qui Parle, Lac-qui-Parle County.—4. Between 15th and 20th of May. 6. About 1 in 100 failed. 7. Sandy soil, gravelly knolls and points; breakings done in 1877. 8. Same as 7.—[Morrill.

Vicksburg, Renville County.—4. April 30 to May 24, 1877. 5. April 30 to May 24, in previous years. 6. One-half; red bug and grub. 7 and 8. Dry and sandy.—[Hale.

Morris, Stevens County.—4. May 10 to 20. 6. Large part; red parasites. 7. Road-sides and edges of fields. 8. Rather sandy soil.—[Heath.

Kandiyohi, Kandiyohi County.—4. April 30 to May 10–22. 6. All hatched.—[Whitney.

Oak Lake, Becker County.—4. May 10 to 15. 5. May 15 to 20. 6. Small percentage; red parasites. 7 and 8. Streets, roads, cattle-yards, gardens, and hard, dry, sandy soil generally.—[McGrew.

Otoe, Pope County.—7. Dry, sandy soil, free from water. 8. Dry, sandy soil, free from water.—[Hoffman.

Pelican Rapids, Otter Tail County.—4. Saturday and Sunday, May 19 and 20. 5. Twentieth to 25th of May, 1875. 6. Two-thirds destroyed by cultivating, breaking last fall, and by birds and parasites. 7. New breaking, gravel and sandy knolls. 8. Breaking and knolls.—[Mrs. Colby.

Moorhead, Clay County.—4. May 12 to 20. 5. Fifth to last of May. 6. Two-thirds failed; cause, red bug. 7. Land without vegetation on surface.—[Unknown.

Fairmount, Martin County.—4. April 14. 6. Many rotted in 1875–'76; the red-bug is doing some good this year. 7. Any bare spot.—[Bullard.

Bigelow, Nobles County.—4. May 15 and 16, 1877. 5. May 20 and 21, 1874. 6. Six-tenths failed; 60 per cent. destroyed by red-bug and three different kinds of worms. 7. High, rolling, sandy, gravelly, stony; last year's breaking or new sod. 8. New breaking, hard earth, and on spots of prairie burned in July and August, 1876.—[McDowell.

Detroit, Becker County.—4. May 15 to 20. 5. May 20. 6. Three-fourths failed; cause, red parasite and white grub. 7 and 8. Sandy soil.—[Day.

Saint Peters, Nicollet County.—4. Last of May. 7. Grass-lands and new breakings. 6. One-tenth hatched.—[Arnold.

Morristown, Rice County.—4. May 28. 6. Two-thirds failed; cause, a larva.—[Kenney.

Monticello, Wright County.—4. From second week in May to 1st of June. 6. Five per cent. failed; maggot, prairie-chickens, blackbirds. 7. Clay and sandy-soil roads, breaking old pastures, old deserted fields; any good, warm, bare spot. 8. Timothy patches, light sandy soil.—[Mehose.

Lake Park, Becker County.—4. May 1 to 15. 7. Bare, dry places.—[Holton.

Raymond, Stearns County.—4. May 10 to June 1. 7. Sandy loam, new breaking, old land, and prairie-sod. 8. Sandy, dry, rolling.—[Raymond.

Banks, Faribault County.—4. June. 6. One-sixth: cause: changeable weather. 7. Rather high, hard, or sandy. 8. Dry, sandy soil.—[Payne.

Golden Gate, Brown County.—4. May 10. 6. Three-fourths exposure; little red bug. 7 and 8. In the edge of timber; prairie-sod broken the previous year.—[Letford.

Kerkhoven, Swift County.—4. May. 6. Forty per cent. destroyed by insects; freezing and thawing weather in winter and spring.—[Jacobson.

Pipe Stone, Pipe Stone County.—4. May 10 to 20. 7 and 8. On breaking and sandy knolls.—[Sweet.

Jackson, Jackson County.—4. Between the 10th and 25th of May. 6. One-fourth failed; warm, open weather in March and February, and freezing afterward. 7. High, open grounds; roads new breaking. 9. June 19.—[Fiddes.

Willmar, Kandiyohi County.—4. Between 8th and 20th of May. 7. New breakings, gardens, &c. Those plowed under did not hatch.—[Haly.

New Auburn, Sibley County.—4. 1st to 10th of May. 5. 10th to 20th of May, 1875. 6. One in 100; small red bug. 7 and 8. New breaking; black sandy loam; high and exposed places.—[Clevinger.

Norseland, Nicollet County.—4. Between 24th and 30th of April. 5. Between 18th and 24th of May. 7 and 8. High, solid ground, late-mown meadows, well-grazed pastures.—[Webster.

Albert Lea, Freeborn County.—4. About June 1. 5. Three-fourths or more; wet. 7. High, sandy knolls and breakings. 8. High sandy knolls and breakings if heavy and clayey.—[Johnson.

Norwood, Carver County.—4. May 1 to June 20. 5. June 1. 7. Old abandoned fields and breakings. 8. Sandy.—[Tiffany.

Becker, Sherburne County.—4. May 1 to June 13. 5. May 25. 7. Breakings and unplowed fields. 8. Sandy loam.—[Wagner.

Orr, Jackson County.—4. May 15 to 20. 5. May 10 to 15, 1875. 6. One-half; red mite, birds, fowls, &c. 7 and 8. Bare ground with southern slope, some sandy.—Palmer.

South Bend, Blue Earth County.—7. Sandy. 8. In sand, and all over at present.—[Davis.

Heron Lake, Jackson County.—4. 10th to last of May. 5. 10th to last of May. 6. One-fifth to one-third; red parasites; plowed land.—[Edwards.

Wilton, Waseca County.—4. The first week in June. 8. Elevated portions.—[Keneban.

Carver, San Francisco Township, Carver County.—4. May 1 to 20. 6. Large proportion failed; little white grub. 7. High, dry soil, with compact surface, and road-sides. 8. Light, dry, sandy soil, facing the south.—[Dunn.

West Newton, Nicollet County.—4. Beginning of May to 7th of June. 5. In May. 7. New breakings, corn-fields, and gardens. 8. Ditto.—[Kyllander.

Collins, McLeod County.—4. May 12 to 20, 1877. 5. May 20 to 25, 1875. 6. 15 per cent. (1877) of those deposited in marshes; dragging in the fall destroyed a few. 7. New breaking and corn-fields. 8. High, dry, rolling lands, the more compact the more successful the hatch.—[Canfield.

Dassel, Meeker County.—4. May 25 to June 15. 7. Dry, hard soil; road-sides; soil descending south and east; south and east side of buildings; stumps and large logs.—[Maxon.

Seward, Nobles County.—4. May 15 to 25. 5. May 3 to 13. 6. One-half to one-third red mite, rot, birds, and chickens. 7 and 8. Gardens, high, dry knolls, well-trodden breaks.—[Terry.

Nashville, Martin County.—5. Early spring, 1874. 7. Hard knolls, old pastures, not very particular, only not on prairie. 8. High, dry places, with southern exposures.—[Bottomly.

Jackson, Jackson County.—4 and 5. May 15. 6. Red parasites destroyed many. 7. Cornfields, highways, gardens. 8. High ground.—[Chamberlain.

Alexandria, Douglas County.—4. A few in February; most April 20 to June 1. 6. one-fifth; cause, red mite, plowing under, and dragging. 7 and 8. Hard, dry, sandy soil, destitute of grass and vegetation.—[Donaldson.

Albert Lea, Freeborn County.—4. June 1. 6. One-half; late and wet weather. 7. Dry ridges, sandy knolls, new breaking, side hills, old roads. 8. Sand and gravel.—[Parker.

Excelsior, Hennepin County.—4. June 15. 7. Southern slopes and timothy pastures.—[Powers.

Dewald, Nobles County.—4. May 8 to 17. 5. May 8 to 17, 1874. 6. On some farms all failed, others 50 per cent; caused by red parasites, and rotting. 7. High, warm soils, south slopes. 8. High, warm soils, south and east slopes. 9. Gravelly ridges; prairie sod.—[Bates.

Tenhassen, Martin County.—4. May 20 to June 2, 1877. 5. May 10. 7 and 8. Sandy soil, hard roads close to fences.—[Merry.

Alexandria, Douglas County.—4. Latter days of April and former half of May. 7. Sandy, loamy soil, railroad cuts, and banks of a sandy character. 8. Same as 7.—[Abercrombie.

Glenwood, Pope County.—4. May 15 to June 1. 7. New broken prairie, sandy clay. 8. Earliest on sandy soil and land sloping to the south.—[Campbell.

Excelsior, Hennepin County.—4. May 1 to June 15. 7. Southeast exposures. Sandy bare spots, pastures; close fed, &c.—[Post.

Watab, Benton County.—4. May 20. 7 and 8. Sandy and dry.—[Gilman.

Windom, Cottonwood County.—4. May 10 to 21. 5. Latter half of May; a few on southern slopes of sandy knolls as early as April 15. 6. Three-fourths failed; cause, red parasite. 7 and 8. New breaking generally.—[Huntington.

Magnolia, Rock County.—4. April 25 to May 16. 6. Three-fourths destroyed; animals, birds, and insects. 7. Sod broken last summer in roads and beaten paths. 8. Sandy loam.

Alden, Freeborn County.—3. Last 10 days of May. 6. One-tenth; open winter, then frost (cause). 7. Sandy loam, gravel knolls.—[Cross.

Cooleyville, Steele County.—4. 10th to 15th of June. 6. Nine-tenths failed; all deposited in low, wet, and muck land rotted. 7. Hard dry knolls; breaking road-sides.—[Clark.

Detroit, Becker County.—4. June 5, 6, and 7. 6. About one-fourth: cause (in his opinion), "The commencement of the end of these pests." 7 and 8. Sandy and hard soil; new breaking, old roads.—[Wood.

Holmes City, Douglas County.—4. Through May. 7. New breaking, road-sides, &c.—[Blackwell.

Grafton, Sibley County.—4. Last of May, 1875 and 1877. 6. One in 1,000 failed. 7. breaking; hard, compact soil.—[Gardner.

Burnhamville, Todd County.—4. May 25 to June 10, in-plowed ground; 10 to 15 days sooner when not disturbed. 6. 90 per cent. rotted. 7. Firm, sandy land. 8. Firm, sandy land.—[Rhoda.

Hersey, Nobles County.—4. May 12 to 20. 5. Before May 15. 6. About one-half destroyed by red parasite and white grub; some by birds; few rotted. 7. In roads on breaking; few on prairie. Soil sandy loam, 2 feet deep.—[Cunningham.

Clear Lake, Sherburne County.—4. From 1st to 10th of May. 7. Last year's breaking. 8. Last year's breaking.—[Frye.

Detroit, Becker County.—4. May and June. 5. May and June. 6. About one-half; cause, red bug. 7. Sandy soil, with southern slope. 8. Sandy soil, with southern slope.—[McLelland.

Avon, Stearns County.—4. May. 6. One-fifth. 7. Light sandy soil.—[Brakefield.

Madelia, Watonwan County.—4. May 10 to 15. 7. High exposures and roads; hard-packed ground near buildings and roads. 8. High dry lands.—[Sylvester.

Herman, Grant County.—3. Loose, deep soil surrounding marshes. 4. May 1, middle of May, and June 1.—[Hodgson.

Alexandria, Douglas County.—4. May 15 to June 15. 5. Last of August to September 15. 6. Red parasite destroyed some. 7 and 8. Sandy soil, bare hill tops and sides, new breakings, and stubble-fields.—[Whitcomb.

Sibley, Sibley County.—1. Most of the eggs hatched between the 10th and 25th of May. 6. One-fourth. 7. High, open ground, in roads, new breakings, &c.—[Woodbury.

Wegdal, Chippewa County.—4. Last of May and first of June. 5. Same time. 6. Small proportion not hatching; cause, parasites, rain, and heavy soil. 7. Sandy soil facing south.—[Rollerson.

Mankato, Blue Earth County.—7. Generally sandy knolls and soils in which sand predominates.—[Mias.

Blue Earth City, Faribault County.—4. From middle of May to June 1. 5. First part of May. 7. Pasture grounds; notable on sheep pastures.—[Bonwell.

Morristown, Rice County.—4. I think the most of the grasshopper eggs are now, June 17, hatched, except under the following circumstances: There are several pieces of land that were plowed quite early, before any of the 'hoppers hatched. This land is now being plowed with a shovel-plow, being planted to corn, and as soon as the ground is stirred up with the shovel-plow, the same day and the day following, and I do not know how many days, the young 'hoppers come forth in large numbers. We had supposed they were past resurrection. I have not heard any complaint of plowing done late in the fall. Mr. Chislone's farm, east of mine, is full of 'hoppers that have come out since he plowed out his corn. Another field west of mine plowed early is the same way. I have 12 acres of corn that they have ate considerably before being plowed out; six acres more on timothy sod that is not so bad, except on the edge of the field.—[Seth H. Kenny.

Saint Cloud, Stearns County.—3. Eggs began to hatch about the 10th of May, and seemed to be most numerously hatching about the 25th. 6. I think all are hatched about the 7th of June, except perhaps a few that have been plowed under in heavy soil. Eggs were mostly deposited in dry and hard soils, mostly on high ground, new breaking, old unused roadways, and on the sides of the beaten track of used roads.—[J. T. Salter.

MISSOURI.

Graham, Nodaway County.—6. I have examined grasshopper eggs here April 25, and find not over 1 per cent. that will hatch; July 25, not one-half ever hatched.—[J. Morton, P. M.

Diamond City, Jasper County.—4. They hatched in February and March; again from April 20 to June 1. Those hatched prior to April 20 perished with wet and cold. 6. I think probably one-tenth, on account of the warm weather in November, February, and March, causing them to swell. 7. In high, dry, and hard ground; preferred bare ground if hard.

Oregon, Holt County.—The hatching was from last of March to the middle of May.—[Clarke Irvin.

NEBRASKA.

Hooper, Dodge County.—4. 10th to 20th of April. 5. 10th to 30th of April. 6. One-third failed; cause, mild winter weather. 7. Dry, sandy, naked, hard or compact soil, and on new breakings and road-sides.—[Eisley.

Salem, Richardson County.—5. Last of April to 1st of May. 6. About 5 per cent.; cause, cold rains. 7. Any kind of soil when smooth and hard. 8. June 1.—[Lincoln.

Friend, Saline County.—4. May 1 to 15. 5. May 1. 6. About 25 per cent. 7. Deposited in hard-ground, sloping toward south; new breaking; early fall, plowed land. 8. New breaking.—[Whitcombe.

Tecumseh, Johnson County.—4. From March to May and June. 5. May. 6. Three-fourths or more; wet season. 7. Slopes of hills, roads, and pastures; usually they select hard ground. 8. Light soil, sandy; south and east slope of hills.—[Holmes.

Chapman, Merrick County.—4. April 15. 8. Sandy and clay about equal; hatched on sandy land first.—[Cox.

Amazon, Franklin County.—April 15. 5. May 10, 1875. 7. Last year's breaking, and on cultivated land that had become packed.—[Hendricks.

Niobrara, Knox County.—4. Early part of February, 1877. 6. Large numbers were frozen after the warm weather in February; cold wet weather. 7. Sandy, high roads. 8. Plowed and sandy grounds.—[Hulliban.

Glencoe, Dodge County.—4. May 15 to June 4, most numerously May 17. 7. Hard bare ground. 8. On land that had been plowed under.—[Dodge.

Fremont, Dodge County.—4. April 19 to May 11. 7. Most on new breaking; then clear ground; next, sand ridges; few, if any, on grass-land or stubble. 8. Hatched where most deposited.—[Blanchard.

Burr Oak, Otoe County.—4. April 22, April 28, May 9. 6. About seven-tenths failed; cause, cold, damp weather, and deep plowing. 7. Old pastures and ground adjoining corrals.—[Davidson.

Grand Island, Hall County.—4. April 6 to 13. 6. One-fourth failed; cause, white maggot; warm winter; spring freezing. 7. Warm, sandy, well-settled soil, as corn-fields and pastures where there are bare spots.—[Stolley.

Plattsmouth, Cass County.—4. April 28 to May 5, 1877. 7. Hillsides with south exposure, or roadsides hard packed. 8. Same as 7.—[Wheeler.

Hebron, Thayer County.—4. April 15 to 20. 6. Say 60 per cent.; cause, cold, wet weather. 7. Sandy loam in dry situations. 8. Same as 7.—[Fitchpatrick.

Plattsmouth, Cass County.—4. From 16th to 20th of April. 5. Sometimes as early as March 25; mostly April 5 to 10. 6. It is estimated that one-third failed to hatch; cause, disturbing, breaking up the eggs, scattering, exposing, &c. 7. A compact earth

or a path on firm bare ground exposed to the sun. 8. Warm, sunny exposures not beaten too hard.—[Child.

Steele City, Jefferson County.—4. March 20, in large quantities. 7. A bare sandy soil, or on hillsides. 8. Sandy soil or bottom land.—[Gantt.

Sunlight, Cass County.—4. May 15, 1877. 5. May 10, 1875. 6. But few fa led. 7. Soil with a clay tendency, and well drained. 8. Same as 7.—[Babbitt.

Falls City, Richardson County.—4. May 21 to 28, 1877, in great numbers. 5. About the middle of April, 1875.—[Unknown.

Farmers' Valley, Hamilton County.—4. April 20, 1877. 5. April 20, 1875. 7. Breaking sandy soil. 8. Where deposited.—[Vosburgh.

Genoa, Platte County.—4. April 15. 6. About two-third of the eggs failed to hatch, owing to continued cold wet weather. 7. South and southeastern exposures, and s andy soils along the banks of rivers, and particularly in new breaking. 8. Similar to last.—[Truman.

Pleasant Hill, Saline County.—4. May 19, 1877, in vast quantities. 5. About the same time in 1875 not numerous. 6. About one-half; cause, blowing-off of covering by wind and exposure of eggs. 7. On naked, hard, dry ground, well-fed pastures, old roads, &c. 8. Driest and hardest ground.—[Abbott.

Falls City, Richardson County.—4. Hatching most numerously May 8, 1877. 5. April 19 to May 8 in 1867, 1868, 1875. 6. One-half per cent. failed in 1877.—[Hutchings.

Ponca, Dixon County.—4. May 1 to 15, 1877, greatest numbers. 5. April 1 in previous years. 6. One-sixteenth failed; cause, wet weather. 7 and 8. Newly-broken ground, hard-beaten roads.—[Rockwell.

Arayo, Richardson County.—4. May 28. 5. May 1. 6. Small per cent. in this locality; cause, wet weather and exposure to frosts. 7. Hard soil and spots of bare ground roadways and fall plowing. 8. Same as 7.—[Gerdes.

TEXAS.

Salado, Bell County.—4. Eggs hatched most numerously during March. In places where on one day none could be seen, on the next day the ground would be covered. They deposited eggs in almost all kinds of soil, and, not being choice of location, they filled the hilly and rocky country with their pregeny, as they did the valleys and level prairies, but the hatching was more numerous in open places than elsewhere.—[J. H. Myers.

Calvert, Bell County.—3. None. 4. From the middle of February to the middle of March. 5. January, 1869. 6. There was no general cause to interfere with the hatching, and but few failed. They hatched most rapidly after a rain, and they are still hatching at this date, April 24. 7. Sandy soil covered with weeds and bushes or stubble. 8. Same as above.—[W. L. Coleman.

Austin, Bell County.—Eggs hatched February 10 to March 15. Eggs deposited in dry, sandy soil in bottom-land; in dry, sandy timber-land, and gravelly, clay hill, south side.—[John H. Lecriat.

UTAH.

Smithfield, Cache County.—4. Eggs hatched most numerously from the 15th of April to the 15th of May, 1877. 5. Eggs were hatched in previous years generally about the same time as the present year. 6. From all appearances every egg that was deposited hatched. 7. Eggs mostly deposited in a sandy, gravelly soil. 8. The young were most numerously hatched on sandy, gravelly soil, uncultivated.—[James S. Cantwell.

APPENDIX XIX.

MEANS OF DESTRUCTION.

[Answers to the following questions in Circular No. 1: 16. The means employed in your section for the destruction of the unfledged insects, or to protect crops from their ravages, and how far these have proved satisfactory. 17. The means employed in your section for the destruction of the winged insects, or to protect crops from their ravages, and how far these have proved satisfactory. 18. Descriptions, and, if possible, figures of such mechanical contrivances as have proved useful in your locality for the destruction of either the young or the winged insects.]

DAKOTA.

Olivet, Hutchinson County.—Smoking has been tried with varied success. They were kept off of small gardens and patches by driving.—[Jones.

Sioux Falls, Minnehaha County.—Burning prairie-grass, which does but little good, owing to the fact that so many remain in grain.—[Newton Clark.

Madison, Lake County.—Smoking, which did very little good.—[Law.

Sioux Falls, Minnehaha County.—Sheet-iron pan, 8 or 10 feet long, with a back 1 foot high; bottom covered with kerosene oil. Burning prairies. This is objected to, however, on account of its destroying too many birds' eggs and young and unfledged birds. During a rain the locusts on a large piece of last year's breaking crawled under clods of earth for protection. As soon as practicable the ground was rolled with a heavy roller and the entire number exterminated.—[Everett.

Wahpeton, Richland County.—The sheet-iron 'hopper-dozer, a strip of sheet-iron 12 or 14 feet long, turned up at the back and ends 6 or 8 inches, in front one inch; pan covered with tar, kerosene, soft soap, &c.; whole drawn by wires or cords.—[Smith.

Milltown, Armstrong County.—Kerosene oil.—[Taylor.

Saybrook, Clay County.—The tin pan and kerosene oil; burning hay, straw, &c.—[Hall.

Sioux Falls Post-Office, Lincoln County.—Nets were used, but the outlay of labor exceeded the benefit derived from them.—[Jacobs.

NEBRASKA.

Burr Oak, Otoe County.—Crushing with heavy rollers, burning prairie-grass and winnows of straw, were means used for destruction of unfledged locusts.—[Davidson.

Fremont, Dodge County.—Sheet-iron pan, 3 to 7 feet long, something in the shape of a road-scraper (the sides being higher). The back part of the bottom is dropped in the shape of a pan 3 inches deep and 1 foot wide, nearly filled with water, which is covered with kerosene oil. The oil kills the 'hoppers, and they sink into the water. The largest pans are without wheels, and are drawn by two men; the short ones are on trucks, and are pushed. Some are made with wire-cloth covers, hung with hinges, so that when the motion stops, the top will drop and secure the 'hoppers.—[Blanchard.

Glencoe, Dodge County.—Burning and plowing under for the young.—[Dodge.

Amazon, Franklin County.—Burning the unfledged by scattering straw and firing the prairie grass.—[Hendricks.

Grand Island, Hall County.—Canfield Grasshopper Exterminator, with coal-oil for the unfledged.—[Stolley.

Salem, Richardson County.—Unfledged: Principally sheet-iron pan, 8 feet long, 2 feet wide, edges turned up in front 1 inch, 3 inches on back; back 20 inches high; muslin, well saturated with coal-oil placed in bottom; drawn by two boys or men. * * * With better success, a box 12 to 14 feet long, bottom 4 inches wide, made out of 1-inch lumber; top, with space between, for 'hoppers to jump into; wire screen and box behind for their reception. The locusts remain until the box is filled. Ten bushels per day have been captured by this machine. Burning, ditching, &c., have also been resorted to.—[Lincoln.

Tecumseh, Johnson County.—Coal-tar, kerosene, and nets; ditching and plowing also very satisfactory. The nets and platforms for tar were built on runners, and drawn by horses.—[Holmes.

Hooper, Dodge County.—By burning straw, plowing the eggs under deep on cultivated soil, by various traps and machines, and, above all, by protecting the birds. The essential features of the machines used are: 1st. A platform that runs on the ground on runners or wheels. 2d. A canopy, meeting platform at an angle. 3d. A reservoir at

the junction of the two, containing water or coal-oil or both. The 'hoppers, jumping, will strike the canopy and fall into the reservoir.—[Eisley.

Hebron, Thayer County.—For destroying unfledged, have depended upon blackbirds principally, they having proven themselves competent if in sufficient numbers. For full-grown, driving with smoke has been tried with moderate success.—[Fitchpatrick.

Falls City, Richardson County.—Pans of galvanized iron, 8 feet long, only practicable on smooth prairie and short, small grain. Have been working a large brush on the prairie with four horses. It is carried on wheels in front and weighted down behind. Not so successful as expected.—[Hutchings.

Farmers' Valley, Hamilton County.—Burning the prairie-grass destroyed large numbers of the young, unfledged locusts.—[Vosburgh.

Sunlight, Cass County.—Burning prairie-grass, straw, and hay all satisfactory.—[Babbit.

Falls City, Richardson County.—One of the most effective means now being used is coal-oil in shallow sheet-iron pans.—[Smith.

Pleasant Hill, Saline County.—Burning straw.—[Abbott.

Plattsmouth, Cass County.—Burning prairies and straw-piles. Hand-machine, 12 feet long, drawn by two men.—[Child.

Friend, Saline County.—1. Harrowing during fall, winter, and early spring. 2. Destroying the insect by bushes, boards, &c., while very young. 3. Digging trenches, and driving them in, where they are easily destroyed; placing straw around growing crops as a resort, and burning early in the morning and late at night. 4. Driving them into unburned prairie and firing the same. 5. Various machines constructed for their destruction.—[Whitcombe.

Arago, Richardson County.—Pans of sheet-iron or zinc, &c., with a mixture of kerosene oil, coal-tar, turpentine, and lime-water. This has proved very satisfactory. Trenches have been dug. A machine-like a reaper, consisting of an elevator which carries the insects from the front edge of the platform and crushes them there. Back of this are two rollers which crush all that may escape the elevator. This works very satisfactorily.—[Gerdes.

Ponca, Dixon County.—A sheet-iron scoop drawn against the wind, the bottom holding kerosene oil. No means have been used for destroying the winged insects.—[Rockwell.

Steele City, Jefferson County.—There are several contrivances in use for catching the young. I have just heard of one that catches them in front and passes them back through two rollers to crush them.—[Gantt.

IOWA.

Estherville, Emmett County.—Preserving the prairie-grass and burning on the 18th May.—[Jarvis.

Alta, Buena Vista County.—Sheet-iron pan and coal-oil have given good satisfaction.—[Crowell.] The catching of unfledged 'hoppers by machines has proved a great success. Burning straw around gardens was resorted to with some success. The "Nebraska catcher" is almost altogether used now in this section.—[Thompson.

Pringhar, O'Brien County.—Unfledged: Coal-oil pans and ditches. Winged: Sheet-iron boxes on wheels with high backs. 'Hoppers rise; fall into box; not very successful.—[Langshore.

Dakota City, Humboldt County.—The kerosene-oil pan is best. The same pan filled with strong soap-suds did the same execution. Coal-tar pans were good, but more trouble to use.—[Adams.

Fort Dodge, Webster County.—A long box about one foot square, covered with wire-cloth. The box is raised a little from the bottom piece to make a draught of air through. A lip projects in front, something on the principle of the cow-catcher on an engine. Drawn by horses or any other power. It is claimed that 140 acres can be effectually cleared in one day.—[Mrs. Swain.

Spirit Lake, Dickinson County.—A long box on runners, with a front made of tin; the top of wire-cloth. The insects are killed with hot water. Another machine, which appears to be preferable, is composed of rollers, which revolve under a canopy of cloth, the back part of which is white. The insects jump toward the light, drop on the roller and are crushed. On the under side is a scraper to clear the rollers. It works well for the young, and winged also.—[Mosher.

Lake City, Calhoun County.—Rolling the fields with heavy rollers where the land is smooth; scattering hay and straw in places where they are thick, and burning it; burning prairie-grass in the spring. The great objection to this is that it destroys too many young birds and eggs.—[Jack.

Sioux City, Woodbury County.—Have the most confidence in the kerosene pan of any of the means used for destroying locusts.—[Skinner.

Hazard, Cherokee County.—Some have drawn straw and scattered it 6 to 8 feet wide, and after driving the young 'hoppers into it have burned it. Some use a tin pan 12 feet long set in a wood box, and holding a little kerosene oil; others, a similar one 6

feet long drawn by hand. A trap which will hold two bushels of 'hoppers is also used —[Pierce.

MINNESOTA.

Alexandria, Douglas County.—Burning, ditching, tar-dozers, and nets. Success but partial.—[Whitcomb.] Ditching around; and a piece of board or sheet-iron covered with coal-tar, and pulled or drawn along the ground.—[Abercrombie.

South Bend, Blue Earth County.—Unfledged: Ditching. Winged: Nets.—[Davis.

Raymond, Stearns County.—Ditches, 'hopper-dozers, coal-tar, and kerosene, all used without effect.—[Raymond.

Cosmos, Meeker County.—For destroying the winged, a line has been dragged across the field by two men, thus disturbing the 'hoppers so that they sometimes leave. Sheet-iron pans, with coal-tar in them, have been used for destroying the young.—[McDonald.

Mankato, Blue Earth County.—Ditching very successful. 'Hopper-dozers with coal-tar and kerosene spread on surface very effective.—[Mias.

Janesville, Waseca County.—Late plowing, dragging, sheet-iron pan, and coal-tar.—[Headly.

Albion, Wright County.—Coal-tar and lime made into a whitewash and put onto a sheet-iron pan. Nets made of sheeting, about 3 feet long, attached to a bow, put into a strip of board about 2 inches wide and 3 feet long.—[Howard.

Albert Lea, Freeborn County.—Burning and tar-dozers.—[Johnson.

Burnhamville, Todd County.—For the young, coal-tar has been used with some success when the grain is not over 6 to 8 inches high. Ditching has been made use of only in isolated cases, but is the most effective remedy.—[Rhoda.

Avon, Stearns County.—A sheet-iron pan, 6 to 7 feet long by 2 to 3 feet wide, raised 2 or 3 inches on the back, with a strip of muslin raised above and smeared with tar. This is dragged over the ground and seems to be death to them.—[Brakefield.

Worthington, Nobles County.—Burning the prairie-grass and plowing deep for the young.—[McDowell.

Holmes City, Douglas County.—Burning with hay or straw; did no good.—[Blackwell.

Detroit, Becker County.—Burning the prairie-grass. Sheet-iron pan with coal-tar or kerosene.—[Day.

Cooleysville, Steele County.—Plowing under the eggs and the young when they first hatch; also, coal-tar and 'hopper-dozer.—[Clark.

Alden, Freeborn County.—Two sheet-iron pans, each 16 feet long, attached to a sulky-rake, one three or four feet in the rear of the other, covered with tar, with an apron of light cloth attached to the rear pan to prevent them from hopping over the pans.—[Cross.

Madelia, Watonwan County.—1st. Tar pans. 2d. A machine mounted on wheels with reel in front, with pan of coal-tar. This runs in front of team, and when vegetation is too high the reel can be removed, and by pushing it rapidly against the grass after the 'hoppers have gone to roost, they very readily fall into the tar.—[Sylvester.

Detroit, Becker County.—Coal-tar and coal-oil have been used with good success. A dray of sheet-iron smeared with tar is commonly constructed, to be pulled by horses.—[Wood.] Sheet-iron pan and coal-tar.—[McLelland.

New Auburn, Sibley County.—Ditching and catching in sheet-iron pans covered with coal-tar.—[Clevinger.

Clear Lake, Sherburne County.—Sheet-iron pans with coal-tar; ditching and dragging.—[Frye.

Hersey, Nobles County.—The sheet-iron pan with coal-tar has done excellent service Smudges of any kind of material that will make a dense smoke have been used, but generally with poor success.—[Cunningham.

Norseland, Nicollet County.—Burning coal-oil smeared on large sheet-iron plates; no great benefit. A board fence two feet high, perfectly tight, with a three-inch batten nailed to the top so that the batten is on the outside of the field. The edge of this smeared with coal-oil three or four times a day. When the 'hoppers come to the fence they will march up until they come to the batten, when smelling the coal-oil they will either retreat or jump and fall back on the ground ready for another trial; finally they will commence to march in one direction alongside the fence, where an occasional pit is ready to receive them; and by accumulating in these pits they will die of themselves. Thirty bushels have been caught in one pit. Very successful. Winged: Large bag attached to wheels, with another sack to empty them out through.—[Webster.

Saint Peters, Nicollet County.—Ditching; nets.—[Arnold.

West Newton, Nicollet County.—Burning straw and ditching; latter but little use.—[Kyllander.

Norwood, Carver County.—Ditching round the exposed sides of the field is the best method while they are young. Sheet-iron pans and tar will catch some of the winged ones.—[Tiffany.

Golden Gate, Brown County.—Nets, and pans of sheet-iron 8 or 9 feet long, 2 feet wide,

and 2½ inches deep, bottom lightly covered with kerosene oil or tar. Burning straw did some good.—[Letford.

Banks, Faribault County.—Two sheet-iron pans, one behind the other, saturated with coal-tar, drawn by two men or one horse.—[Payne.

Becker, Sherburne County.—Sheet-iron pan with coal-tar; burning and ditching; all very good.—[Wagner.

Glenwood, Pope County.—Coal-tar on sheet-iron boats; supplied too late to do much good.—[Campbell.

Morristown, Rice County.—Digging pits; burning straw. Very successful.—[Kenney.

Dassel, Meeker County.—Coal-tar pans are successful.—[Maxon.

Willmar, Kandiyohi County.—Tar-pans not as successful as ditching round the fields.—[Haly.

Sibley, Sibley County.—'Hopper-dozers used with varying success.—[Woodbury.

Kerkhoven, Swift County.—Tar-pans; burning with straw; prairie-fires; ditching to the depth of seven or eight inches, in which are pits at intervals of two or three rods; the young 'hoppers walk into the trenches and afterward into the holes (made with fence-post augers) and are buried with dirt.—[Jacobson.

Carver, Carver County.—'Hopper-dozers; ditching; both give good satisfaction.—[Sulter.

Wilton, Waseca County.—Tar-pans; nets; harrowing; all satisfactory.—[Kenehan.

Heron Lake, Jackson County.—Tar-pans are used successfully.—[Edwards.

Jackson, Jackson County.—Tar-pans decidedly effective.—[Chamberlain.

Magnolia, Rock County.—Burning prairies.—[Unknown.

Detroit, Becker County.—Burning prairie-grass; tar-pans also good.—[McLelland.

Seward, Nobles County.—Burning wild grass little or no use; burning hay and straw around the field a little better; straw burnt in a ditch better still; none really pay; tar-pans nearly a complete success.—[Terry.

Worthington, Nobles County.—Burning prairie-grass; plowing deep; farmer most effectual.—[McDowell.

Nashville Centre, Martin County.—Tar-pans for winged and unfledged locusts.—[Bottomly.

Orr, Jackson County.—Burning prairie-grass, hay, and straw; tar-pans.—[Palmer.

Tenhassen, Martin County.—Burning grass, hay, and straw had no effect as locusts were too numerous; tar-pans were not satisfactory.—[Merry.

Albert Lea, Freeborn County.—Tar-pans; advantageous with short vegetation.—[Parker.

Collins, McLeod County.—Burning prairie-grass, straw, &c.; tar-pans.—[Canfield.

Dewald, Nobles County.—Tar-pans; burning prairie-grass; best results from deep fall plowing.—[Bates.

Worthington, Nobles County.—Tar-pans; successful.—[Churchill.

Lake Park, Becker County.—Dozers; ditching and burning.—[Holton.

Monticello, Wright County.—Trenching; burning and 'hopper-dozers.—[Mehose.

Excelsior, Hennepin County.—Tar-pans; nets; efficacious.—[Powers.

COLORADO.

Larkspur, Douglas County.—Irrigating where practicable.

OREGON.

Clarksville, Parker County.—The means employed for the destruction of the winged insects, or rather for the protection of the crops, was smoke from the burning of old bones, but with poor success.—[Heisy.

APPENDIX XX.

ESTIMATES OF INJURY; MANNER IN WHICH DIFFERENT CROPS WERE AFFECTED.

[Answers to the following questions in circular No. 1: 11. Estimate the injury done in your county and State. 12. Crops which suffered most. 13. Crops most easily protected. 14. Crops which suffered least.]

NEBRASKA.

Niobrara, Knox County.—12. Corn. 13. Rye, wheat, barley, oats, or any other bearded grain. 14. The above.—[T. G. Hulliban.

Ponca, Dixon County.—12. 1874, corn, potatoes, cabbage, all gardens without exception; leaves of soft maple and cottonwood, also by gnawing the bark off of soft maple; 1876, August 6th, corn partially, gardens wholly. Gardens three-fourths destroyed; from eight to ten thousand dollars' worth destroyed. 13. Strawberry-vines and pease. 14. Strawberry, pumpkin, tomato, squash vines.—[J. Rockwill.

Hebron, Thayer County.—12. Corn and garden vegetables. 13. Potatoes. 14. Sugar-cane, broom-corn, prairie-grass.

Farmers Valley, Thayer County.—12. Small grains on breakings this year. 13. None special. 14. Crops not on breaking.—[J. Vosburgh.

Glencoe, Dodge County.—12. 1873, everything, total failure of corn and oats. 1876, destroyed everything.—[G. M. Dodge.

Salem, Richardson County.—12, 13, 14. In 1875 no particular crop escaped; all destroyed in the following ratio: Clover, timothy, barley, wheat, oats, and corn.—[J. C. Lincoln.

Friend, Saline County.—11 and 12. This county 20 per cent. corn; this State 50 per cent. corn. 13. Small grain crop; 14. Oats, barley, and wheat, or those which mature earliest.—[E. Whitcomb.

Chapman, Merrick County.—12 (May 1st, 1877). Little damage done yet; probably 1 per cent. (1 acre in 100). 12. Wheat, rye, barley, oats, and corn. 14. Sorghum, broom-corn.—[H. M. Cox.

Pleasant Home, Polk County.—11. Wheat will average 15 bushels to the acre; rye, 20 bushels per acre.—[W. W. Elliott.

Plattsmouth, Cass County.—12. Corn (1876).—[D. H Wheeler.

Fremont, Dodge County.—11. Comparatively little damage done yet (May 11, 1877). 12. Wheat, oats, and tame grass; 14. Winter rye and pease.—[G. F. Blanchard.

Genoa, Platte County.—11. About 15 per cent. 12. Wheat on new breaking; 14, rye.—[Geo. S. Truman.

Plattsmouth, Cass County.—12. Wheat, oats, corn, barley, and garden vegetables. 13. I know of no effectual protection. 14. Potatoes, pease, and sorghum.—[A. L. Child, M. D.

Sunlight, Cass County.—11. (In county) 1874, 25 per cent.; 1875, 50 per cent.; 1876, 10 per cent. 12. 1874, corn and vegetables; 1875, wheat, barley, and vegetables; 1876, corn and vegetables. 13. Corn.—[T. N. Babbitt.

Tecumseh, Johnson County.—11. Not to exceed one-half of 1 per cent., and I think that liberal. 12. Spring wheat and barley. 13. Small grain. 14. Corn.—[C. A. Holmes.

Burr Oak, Otoe County.—11. Amount of injury done in this township up to May 28 1877, is 20 per cent. 12. Barley and wheat. 13. Corn.—[J. H. Davidson.

Grand Island, Hall County.—12. Wheat, barley, rye, oats, by the young. Some damage done early to shrubbery in orchards.—[Wm. Stolley.

Hooper, Dodge County.—11. To May 13, about one-sixth wheat and one-third gardens. 12. Wheat and gardens. 13. All small grain. 14. 1876, corn, flax, potatoes, and late gardens. 1875, corn; most came in August.—[C. F. Eiseley.

Arago, Richardson County.—11. 30 per cent. in the eastern part of the county. 12. Barley, wheat, and oats. 13. All crops were subjected to their ravages, and all crops alike protected. Corn (maize).—[Wm. Gerdes.

Albion, Boone County.—12. Corn crop entirely destroyed in 1874 and in 1876.—[Loran Clark.

Amazon, Franklin County.—11. Not to exceed 1 per cent. of the small grain. 12. Wheat, oats, and barley. 14. Corn, rye, flax, &c.—[H. O. Hendrick.

IOWA.

Dakota City, Humboldt County.—12. Oats. 13. Oats, wheat, barley, &c. 14. Wheat.—[Al. Adams.

Hazard, Cherokee County.—12. Wheat. 14. Barley.—[Merrit D. Pierce.

Fort Dodge, Webster County.—11. May 21, 1877. Little damage yet. 12. Small grains and garden vegetables with juicy leafage. They do not attack young corn if they can get anything else. Prefer young tame grass to any other food.—[Mrs. J. Swain.

Alta, Buena Vista County.—11. Buena Vista County very little damaged. 12. Garden stuffs, excepting pease. 13. Pease and potatoes have not suffered.—[Charles Thompson.

Lake City, Calhoun County.—11. In 1876, about 10 per cent. of the corn crop. In 1874, about 50 per cent. of all crops. In 1868, almost total destruction. 12. Barley, wheat, oats, potatoes, corn, in the order mentioned. 13. Small grains and gardens. 14. Sugar-cane and corn, pease, and potatoes.—[A. N. Jack.

Mount Hope, Sac County.—11. In Eureka Township, Sac County, damage to crops 3 per cent. August 20, 1877. 12. Barley and wheat. 13. All small grain. 14. Oats and corn.—[A. B. Holms.

Estherville, Emmet County.—12. Wheat and oats from invaders. Wheat from those we raise. 13. None. No more than from a hail-storm. 14. Oats, pease, corn, when young. Nothing but what they will eat when hungry.—[C. W. Jarvis.

MINNESOTA.

Dewald, Nobles County.—11. Loss about one-third. 12. Oats, flax, corn, wheat, and potatoes (in the order given) suffered most. 14. Pease, horse-radish, cockle-burr purslane, and helianthus.—[David Bates.

Worthington, Nobles County.—11. Estimates the loss for the county at one-tenth for 1876. 12. Wheat, oats, flax, and corn. 13. Wheat, oats, barley, and flax. 14. Broom-corn, sorghum, pease, and barley.—[Dr. B. D. Churchill.

Excelsior, Hennepin County.—11. No answer. 12. Wheat and oats. 13. Pease and corn.—[George M. Powers.

Lake Park, Becker County.—11. No estimate given. 12. Barley, wheat, and oats, in order given, 1876. 13. Potatoes, corn. 14. Pease and potatoes.—[Theodore Walton.

Albert Lea, Freeborn County.—Loss trifling, June 16, 1877. 13. Not damaged enough in this region to determine.—[D. G. Parker.

Watab, Benton County.—11. No estimate given. 12. All suffered alike. 13. No answer. 14. Barley.—[David Gilman.

Excelsior, Hennepin County.—11. No estimate given. 12. Timothy, barn-grass, clover, weeds (wild), buckwheat, radishes, and lettuce.—[T. Bost.

Tenhassen, Martin County.—11. Crops all destroyed. 12. All crops. 13. No protection. 14. Pease.—[William Merry.

Windom, Cottonwood County.—11. Very little damage in 1877; previous years nearly total destruction. 12. Wheat and oats. 13. None more than others. 14. No general answer can be given.—[C. C. Huntington.

Lake Eunice, Becker County.—11. One-half crops destroyed in the county. 12. Wheat up to July 8, 1877. 13. Wheat most easily protected. 14. Corn, pease, and potatoes.—[John McLelland.

Morristown, Rice County.—11. No estimate given. 12. Onions, corn, beans. 14. Pease, sugar-corn.—[Seth H. Kenney.

Cosmos, Meeker County.—11. No estimate. 12. Wheat and oats. 14. Corn.—[J. N. McDonald.

Alexandria, Douglas County.—11. No estimate. 12. Barley in the ear. 14. Oats in 1877; Field-pease, squash and pumpkin vines, and tomatoes.—[John Abercrombie.

Glenwood, Pope County.—11. Damage estimated at one-half in county. 12. Wheat, corn, potatoes, garden vegetables. 13. Grain more easily than root-crops. 14. Pease and oats, from the young.—[David Campbell.

Detroit, Becker County.—11. But little injury done up to date, May 25, 1877. 12. Grain crops are suffering most, particularly wheat. 13. One as easily as another.—[C. K. Day.

Saint Peter, Nicollet County.—11. No estimate given. 12. Wheat is preferred to oats and corn. 14. Oats, corn, and potatoes.—[J. T. Arnold.

Janesville, Waseca County.—11. Comparatively trifling.—[J. J. Headly.

Nobles, Bigelow County.—12. Cabbage, lettuce, onions, radishes, turnips, beets, tomatoes.—[N. V. McDowell.

Detroit, Becker County.—12. Wheat, oats, and onions. 13. Millet, India buckwheat, pease, and potatoes. 14. Potatoes and India buckwheat.—[F. E. Wood.

Holmes City, Douglas County.—11. Seventy-five per cent. 12. Wheat. 14. Corn and potatoes.—[Henry Blackwell.

Clear Lake, Sherburne County.—11. Very little damage as yet. 12. Beans, wheat, garden vegetables. 13. Corn, rye, pease, sorghum. 14. Rye.—[Daniel Fry.

Seward, Nobles County.—11. No estimates yet. 12. Beans, turnips, cabbage, oats, bar-

ley, wheat. 14. Pease, sugar-cane, and broom-corn, box-elder and black walnut trees are not eaten.—[Alfred Terry.

South Bend, Blue Earth County.— 12. Wheat and everything farmers raise. 13. Not any. 14. Pease.—[D. P. Davis.

Avon, Stearns County.—11. Thinks everything nearly will be destroyed. 12. Last year ruta-bagas, buckwheat, and corn.—[John Brakefield.

Carver, Carver County.—11. Very little injury done to take the country at large. Wheat crop in localities along the Minnesota River almost a total loss. 12. Wheat and garden plants. 14. Corn, rye, oats, and pease.—[Jacob Dunn.

New Auburn, Sibley County,—11. No estimate given. 12. Wheat, barley, and flax. 13. Oats, corn, and pease. 14. Pease, oats, corn, in order named.—[S. S. Clevinger.

Dassel, Meeker County.—11. From 7 to 10 per cent. of wheat crop. Other crops have not suffered much except gardens which have suffered generally. It is estimated that 5,000,000 bushels of wheat have been destroyed in Minnesota this year, 1877.—[S. W. Maxon.

Wilton, Waseca County—12. Wheat.—[Patrick Kenehan.

Nashville Center, Martin County.—12. Garden vegetables. 13. Wheat, oats, barley. Wheat suffered more than other crops in 1874.—[James Bottomly.

Becker, Sherburne County.—12. Wheat and oats. 13. Corn, pease, and potatoes. 14. Corn.—[John A. Wagner.

Willmar, Kandiyohi County.—11. Crops damaged about one-half. 12. Wheat and oats. 14. Pease, pumpkins, and squashes.—[John Haly.

Raymond, Stearns County.—11. In the county, in 1876, 500,000 bushels of grain; in 1877, 1,000,000 bushels. In the State, in 1876, 6,000,000 bushels; in 1877, 8,000,000. In 1875, 120,000 bushels of grain were raised in this township; in 1876, 10,300; in 1877, there will not be 1,000 bushels of grain saved. 12. Wheat, barley, and oats. 13. Pease. 14. Pease and oats.—[L. B. Raymond.

Norseland, Nicollet County.—11. In the county, 90 to 95 per cent.; in the State, 20 or 25 per cent. 12. Wheat, corn, and beans. 13. Pease and oats. 14. Oats, pease, and sorghum.—[John Webster.

Albert Lea, Freeborn County.—11. No damage done in Freeborn in 1876.—[A. M. Johnson.

Pipe-Stone, Pipe-Stone County.—11. Nothing destroyed but a few beets, cabbages, &c., in this county so far.—[D. E. Sweet.

Burnhamville, Todd County.—11. Half a crop, valued at $350,000, in the county. 12. Wheat, barley, corn, timothy, beans, and turnips. 13. One crop as difficult to protect as another. 14. Rye, oats, potatoes, and pease.—[Albert Rhoda.

West Newton, Nicollet County.—11. More than two-thirds in the town of Severance. 12. Garden-vegetables, wheat, oats, tobacco, young trees, and pie-plant. 14. Last year, sugar-corn, broom-corn, and pease; but this year they spare nothing.—[Gustaf Kylander.

Norwood, Carver County.—11. Not much in this county, it being timbered. 12. All kinds more or less. 13. Pease. 14. Wheat, corn, and oats.—[A. W. Tiffany.

Jackson, Jackson County.—11. Very little in this county. 12. Wheat. 13. No difference. 14. Slight damage to any.—[G. C. Chamberlain.

Banks, Faribault County.—11. One-tenth in the county. 12. Wheat, oats, and flax. 13. Any small grain. 14. Corn and pease.—[William O. Payne.

Golden Gate, Brown County.—11. In county, two-thirds; in State, one-fourth. 12. Wheat, oats, and barley. 14. Pease.—[J. S. Lelford.

Sibley, Sibley County.—11. No estimate given. 12. Wheat has been injured most. 14. Oats and pease least.—[C. E. Woodbury.

Mapleton, Blue Earth County.—12. Late corn, turnips, vegetables, and tame grass.—[C. A. Williams.

Paynesville, Stearns County.—12. Wheat, corn, vegetables, tansy, tobacco, wormwood, and spignet. 14. Tomatoes, pease, and oats.—[S. P. Roach.

Brookfield, Renville County.—11. Nine-tenths of the wheat-crop in this town. 12. Wheat. 14. Oats and corn.—[Charles E. Porter.

Moorhead, Clay County.—11. Injury so far insignificant. 12. Young garden-vegetables just coming up, onions, beets, lettuce, cabbage, and carrots. Among grain crops, buckwheat, barley, oats, and wheat most liable to destruction in the order named. 13. Can't state; depends on circumstances. 14. Pease, sorghum, and corn, in the order named.—[R. M. Roestfield.

Burnhamville, Todd County.—12. Wheat, barley, artichokes, nettles, wild buckwheat, timothy, clover, onions, tobacco, turnips, cabbage, and beans eaten by old and young. 14. Pease, cucumbers, and the kindred vines, beets, potatoes, corn, and the native grasses.—[Albert Rhoda.

Worthington, Nobles County.—12. Oats, wheat, corn, and all cultivated crops are eaten by bees, young and old. 14. Pease, pumpkins, squashes, and tomatoes.—[N. V. McDowel.

Vicksburg, Renville County.—11. Nine-tenths in this county. 12. Everything but sorghum, pease. 13. Unknown. 14. Pease and sorghum.—[E. B. Hale.

Morris, Stevens County.—11. Half the crops destroyed. 12. Barley, wheat, and oats. 13. No difference. 14. Corn and pease.—[Heath.

Saint James, South Branch Township.—12. All kinds of garden-vegetables, strawberries, wheat, barley, oats, corn, turnips, and potatoes. 14. Tomatoes, pease, squashes, and pumpkins.—[Theo. Lambert.

Oak Lake, Becker County.—11. In 1872, almost total; in 1875-'76, three-fourths. 12. Wheat, oats, barley, rye, corn, and all tame grasses. 13. Potatoes. 14. Tomatoes and pease.—[J. G. McGrew.

Alexandria, Douglas County.—11. Seven-eighths destroyed in Douglas County. 12. Barley, oats, wheat, and corn. 13. None. 14. Pease and squashes.—[George F. Whitcomb.

Saint Cloud, Stearns County.—In 1856, all vegetation eaten up.—[P. L. Gregory.

DAKOTA.

Spring Valley, Turner County.—11. They took three-fourths of everything except native grasses. 12. Corn and garden-sauce.—[S. F. Andrews.

Olivet, Hutchinson County.—11. None. 12. Corn and watermelon-vines. 14. Pumpkin, squash, and cucumber vines and small grains.—[A. Sheridan Jones.

Willowtown, Armstrong County.—11. Comparatively none. 12. Garden-vegetables; easily protected. 13. Gardens. 14. Barley and rye.—[J. W. Taylor.

Wahpeton, Richland County.—12. Wheat. 13. Pease.—[D. Wilmot Smith.

Madison, Lake County.—11. Twenty per cent. estimated in this county (injury). 12. Oats, corn, and garden-vegetables. 14. Wheat, pease, and sorghum.—[J. H. Law.

Saybrook, Clay County.—11. Not more than 5 per cent. yet, May 28, 1877. 12. Wheat and garden-vegetables. 14. Sugar-cane.—[J. W. Hall.

Sioux Falls, Minnehaha County.—11. May 26, 1877, damage as yet none, excepting a few small pieces of flax.—[F. E. Everett.

Jamestown, Stutsman County.—12. All kinds of roots and vines. 13. Pease and beets. 14. Pease and beets.—[Merrick Moore.

Sioux Falls, Minnehaha County.—11. Hardly any to speak of. 12. Corn. 13. Potatoes, early grain, sorghum, flax, hemp, and roots.

APPENDIX XXI.

PREVIOUS VISITATIONS—AID OF ANIMALS.

[Answers to the following questions: 19. If your section was not visited in 1876, please state this fact? 20. If visited any previous years, please give the date? 21. To what extent have birds, domestic fowls, and other animals, domestic or wild, been useful in destroying these insects?]

NEBRASKA.

Plattsmouth, Cass County.—19. We were heavily visited in 1876. 20. 1857, 1858, 1861, 1864, 1867, 1868, 1869, 1873, 1875. Domestic fowls in gardens, home lots, &c., are very useful. Birds little use.—[Child.

Albion, Boone County.—20. 1874, 1875, 1876.—[Clarke.

Falls City, Richardson County.—20. 1866, 1867, 1868, 1869, 1874, 1875, 1876.—[Hutchings.

Glencoe, Dodge County.—20. 1873, 1874, 1875, 1876, 1877.—[Dodge.

Arago, Richardson County.—19 Visited and eggs deposited, September. 20. 1866, 1867, 1874, 1876. 21. To no apparent extent.—[Gereres.

Hebron, Thayer County.—19. Visited after harvest; little injury. 20. 1874. 21. All kinds of birds and domestic fowls destroy vast numbers.—[Fitchpatrick.

Niobrara, Knox County.—19. In large numbers; did little damage. 20. 1874, 1875; former took everything. 21. Very useful in destroying young 'hoppers, but do not touch the winged ones.—[Hulliban.

Farmers Valley, Hamilton County.—19. August, 1876, in swarms and deposited eggs. 20. July 21, 1874; left July 31, 1874; deposited. 21. Blackbirds, domestic fowls, prairie chickens, quails; eggs and young locusts.—[Vosburgh.

Sunlight, Cass County.—19. Visited in 1876. 20. July 26, 1874; June, 1875. 21. Very useful.—[Babbitt.

Steele City, Jefferson County.—20. July 26, 1872, 1873, 1874, 1876. 21. Good, especially the quail.—[Gantt.

Ponca, Dixon County.—19. Was not. 21. Very little use; the fowls become disgusted with so many.—[Rockwell.

Ponca, Dixon County.—20. August 9, 1872; May 28, 1873.—[Rockwell.

Plattsmouth, Cass County.—19. It was visited. 20. Spring, 1857; spring, 1867; fall, 1874; September, 1875. 21. Very large extent.—[Wheeler.

Genoa, Platte County.—21. Blackbird, cowbird, and domestic fowls destroy large numbers of eggs and young locusts.—[Truman.

Glencoe, Dodge County.—21. Hogs, dogs, and poultry are very fond of them.—[Dodge.

Tecumseh, Johnson County.—19. Were, but no damage done. 20. July, 1874. 21. Very largely. Blackbirds have been our most valiant friends. All birds, as well as domestic fowls, have aided.—[Holmes.

Chapman, Merrick County.—19. Most severely visited in 1876. 20. May 15, 1873; July, 1874; June, 1875.—[Cox.

Amazon, Franklin County.—19. It was. 20. Only in 1874 to do much damage. 21. They have destroyed about one-half.—[Hendricks.

Friend, Saline County.—19. This section was visited in 1876. 20. 1874 and 1878. 21. Prairie-hens, quails, snipes, blackbirds, &c., are useful.—[Whitcombe.

Grand Island, Hall County.—20. August, 1862; August, 1864; July 15, 1865; July 8, 1866; 1868, 1869; May 22, 1873; July and August, 1874; June and August, 1875.—[Stolley.

Hooper, Dodge County.—20. About every other year. 21. Blackbirds, snowbirds, Prairie-chickens, domestic fowls, &c.—[Eisley.

Burr Oak, Otoe County.—10. It was visited in 1876. 20. August, 1874. 21. All domestic fowls and hogs eat them with avidity.—[Davidson.

IOWA.

Spirit Lake, Dickinson County.—21. Birds destroy a great number—grakle, yellow-headed blackbird, barn-yard fowls, wheat-birds, &c.—[Mosher.

Mount Hope, Sac County.—19. It was. 20. In 1875, a few. 21. They have destroyed many.—[Holmes.

Lake City, Calhoun County.—19. Yes. 20. September 4, 1867; June 21 or 22, 1873. 21.

Domestic and wild fowls are very efficient in destroying the young. My garden was saved in 1874 by about seventy-five chickens.—[A. N. Jack.

Alta, Buena Vista County.—19. Visited. 21. To no great extent.—[Thompson.

Fort Dodge, Webster County.—19. Came August 18, left August 24, 1876, from north to south. 20. Twice. 21. Birds, squirrels, ground-mice, hogs, domestic fowls, and blackbirds most.—[Mrs. Swain.

Dakota City, Humboldt County.—19. Millions of them. 20. 1869, 1871, 1873, and 1875, with hatching in intermediate years. 21. Chickens have saved gardens here; turkeys also.—[Adams.

Estherville, Emmet County.—19. It was. 20. June 12, 1873. 21. Turkeys and prairie-chickens.—[Jarvis.

Alta, Buena Vista County.—21. Birds, domestic fowls, and hogs. Hogs will plow the ground for them.—[Crowell.

Pringhar, O'Brien County.—19. Was visited in 1876. 20. May, 1873; July, 1874; June, 1875; July, 1876.—[Longshore.

MINNESOTA.

Heron Lake, Jackson County.—19. This is the fifth year this section has been visited. 21. A great many eggs and young locusts are destroyed by all kinds of birds.—[Edwards.

West Newton, Nicollet County.—19. More plenty than in 1876. 20. July 4, 1874, deposited eggs for 1875; came again in 1876 and deposited everywhere. 21. They destroy a good many.—[Kyllander.

New Auburn, Sibley County.—19. It was. 20. 10th to 20th July, 1874; deposited. 21. Probably one in fifty.—[Clevinger.

Norwood, Carver County.—19. Came just as we commenced to stick the grapes in 1876. 20. Last year was the first. 21. Domestic and wild birds do much good, domestic turkey the best.—[Tiffany.

Mapleton, Blue Earth County.—20. July 4, 1874. Remained only a few days.—[Williams.

Worthington, Nobles County.—19. It was. 20. Visited in 1873, 1874, 1876. 21. All wild birds are very useful. The tame ones seem to tire after a few days.—[Churchill.

Albert Lea, Freeborn County.—19. Raids came near September 1, and deposited eggs 1876. 21. Hens and chickens are of great benefit, will keep a garden entirely free from 'hoppers.—[Parker.

Dewald, Nobles County.—19. Visited four years in succession, viz, 1873, 1874, 1875, 1876; last much the worst. 21. Birds are of greatest use, especially blackbird and its varieties. The prairie hen and most other terrestrial birds do good service.—[Bates.

Excelsior, Hennepin County.—19. Not visited until autumn. 20. 1857 and 1858. 21. Domestic fowls are very useful.—[Powers.

Lake Park, Becker County.—19. It was visited in 1876. 20. 1876, 1875, 1874.—[Holton.

Alexandria, Douglas County.—20. Slightly (in a few localities) in 1872 and generally in 1856 and 1857; at this latter date this section was comparatively new and unsettled. 21. Only an imperceptible extent, but a very small fraction of the immense aggregate.—[Donaldson.

Magnolia, Rock County.—19. They visited us in 1876. 20. In June, 1873. In 1874 raised a crop from eggs and were visited by raids the last week in July; 1875, the last week of July and 1st of August; 1876 raised a crop from eggs and received visit from raiders the last week of July.—[Brockway.] 21. They destroy immense numbers.—[Unknown.

Tenhassen, Martin County.—19. Was visited from July 1 to 10, 1876. 20. Was visited June 16, 1873. 21. Domestic and wild birds of all kinds have destroyed considerable.—[Merry.

Windom, Cottonwood County.—19. Visited in 1876. 20. 1875, 1874, and 1873; different times May, June, and as late as August they have alighted each year.—[Huntington.

Excelsior, Hennepin County.—20. Had 'hoppers in 1856 and 1857. 21. Hens are very effective in small patches with young 'hoppers.—[Post.

Watab, Benton County.—19. It was. 20. Here in July, 1856; left in 1857. 21. Blackbirds and hogs to no great extent.—[Gilman.

Saint Peter, Nicollet County.—19. Not until September; did little harm. 20. In 1874, fall, laid eggs and hatched. Ate worse than this year as yet. 21. Very little good.—[Arnold.

Monticello, Wright County.—20. Visited in 1856; left in 1857.—[Mehose.

Morristown, Rice County.—21. Blackbirds, quails, and hens.—[Kenney.

Cosmos, Meeker County.—19. It was. 20. About twenty years ago. 21. Birds and domestic fowls appear to subsist on them, but the difference they make is imperceptible.—[McDonald.

Alexandria, Douglas County.—20. Slightly five or six years ago and eighteen or nineteen years ago. 21. Chickens have been the only destroyers. When caught by the pailfull and given to hogs they appear to eat them with a relish.—[Abercrombie.

Mankato, Blue Earth County.—21. Blackbirds and robins very destructive, but not enough birds in the State.—[Wise.

Glenwood, Pope County.—19. Visited heavily in 1876. 21. Both domestic and wild birds and fowls destroy great numbers of eggs and insects.—[Campbell.

Detroit, Becker County.—19. Millions here in 1876; eggs deposited everywhere in the county. 21. The birds destroy countless numbers.—[Day.

Janesville, Waseca County.—19. Were not. 20. September 1, 1874. 21. Some extent.—[Headley.

Grafton, Sibley County.—20. 1375; 1874 deposited eggs.—[Gardner.

Holmes City, Douglas County.—19. No. 20. July 4, 1864, left in a few days. 21. Ate what they could.—[Blackwell.

Detroit, Becker County.—19. Yes. 20. 1873, 1874, 1875. 21. Blackbirds are powerful aids. Domestic fowls sometimes save whole gardens.—[Wood.

Cooleyville, Steele County.—20. August and September, 1876. 21. To a large extent.—[Clark.

Alden, Freeborn County.—19. August 25, 1876. 20. Never here to deposit eggs. 21. Very small. Turkeys and geese.—[Cross.

Becker, Sherburne County.—20. 1856. 21. Blackbirds best; chickens good; hogs.—[Wagner.

Burnhamville, Todd County.—19. July 19, 1876. 20. Not visited before. Prairie chicken. 21. Crow, robin, turkeys, ducks, and chickens. Twenty chickens and ducklings, when two weeks old, at the time the 'hoppers begin to hatch, will clean out one acre, however thick the eggs were deposited.—[Rhode.

Alberta Township, Sauk Rapids, Benton County.—20. August 13, 1874, deposited eggs; have come every year since, from the first week in August to 10th of September.—[McCulloch.

Avon, Stearns County.—21. A great deal.—[Brakefield.

Detroit, Becker County.—19. It was. 20. For the past six years.—[Unknown.

Hersey, Nobles County.—20. June 13, 1873, deposited eggs, stayed five days. 1874 had the young ones. 1875 came again and deposited eggs very thick. 1876 eggs hatched. July 23 flying 'hoppers came and deposited, which hatched this year. 21. The birds destroy a large number of eggs when exposed by harrowing, also the young.—[Cunningham.

Seward, Nobles County.—20. July 7, 1873, deposited eggs. In 1874 the young took the crops, and raid came and left about the same time. 1875 came and deposited. 1876 a few came last of June. Clouds came July 12. 21. Eggs were too multitudinous for a large proportion to be destroyed by birds.—[Terry.

Madelia, Watonwan County.—20. July 3, 1873. 1874 hatched. 1875, July 9. 1876 hatched and came August 18, and laid for this spring hatch. 21. The best friends we have.—[Sylvester.

Orr, Jackson County.—20. August, 1864. June 12, 1873. 21. Destroyed one in ten.—[Palmer.

South Bend, Blue Earth County.—20. No full crop for four years. 21. 'Hoppers too numerous this year.—[Davis.

Norseland, Nicollet County.—19. In harvest-time in 1876, and deposited. 20. Middle of July, 1874, deposited eggs, which hatched in the spring of 1875. 21. Not to any extent.—[Webster.

Jackson, Jackson County.—19. Crops mostly destroyed in 1876. 20. 1876-'74-'73; a little circle here escaped in 1875. 21. No doubt have been useful.—[Chamberlaine.

Dassel, Meeker County.—19. August 1, 1876, and deposited. 20. Twenty years ago. 21. To no perceptible extent.—[Maxon.

Eagle Lake, Blue Earth County.—20. Fall of 1874.—[Reynolds.] 19. By flying 'hoppers. Laid eggs in August. 20. Domestic fowls like them very well. Blackbirds prefer to dig corn.—[Unknown.

Worthington, Nobles County.—19. We were visited in 1876. 20. July 24 and 25, until August 10, 1876; July 26 to August 8, 1875; August 1, 1874; June 2, 1873. 21. Wild and domestic fowls have destroyed 20 per cent. of the young hatched and 5 per cent. of the raiders.—[McDowell.

Collins, McLeod County.—20. July 4, 1874; 1875; July 18, 1876.—[Canfield.

Le Sueur, Le Sueur County.—19. August 25, 1876.—[Chapman.

Banks, Faribault County.—19. Fall of 1876 for first time. 21. Broods of turkeys or chickens are very destructive. I had a garden of 4 acres covered with 'hoppers. I hatched about 100 turkeys and chickens; in a week they had cleaned them out.—[Payne.

Golden Gate, Brown County.—19. Was visited. 20. Three years from 4th to 15th of July. 21. All kinds of birds to some extent.—[Letford.

Kerkhoven, Swift County.—21. Chickens, turkeys, and other domestic birds were useful; also, the large yellow-headed blackbird.—[Jacobson.

Raymond, Stearns County.—19. First visitation in 1876. 21. They have all been useful.—[Raymond.

Sibley, Sibley County.—19. No 'hoppers were hatched in 1876; swarms came in the fall of 1876. 20. 1857, 1858, 1864, 1865, 1874, 1875, 1876, 1877. 21. To some extent.—[Woodbury.

Herman, Grant County.—19. Were visited for first time. 21. Birds have done good work; blackbirds most.—[Hogeson.

Pipe Stone, Pipe Stone County.—19. Yes, plenty came. 20. No.—[Sweet.

Pelican Rapids, Otter Tail County.—19. Twice in 1876. 20. They have visited this place for the last six years, not always doing damage. 21. They eat all they can.—[Mrs. Colby.

Morris, Stevens County.—19. Yes. 20. 1874. 21. Birds destroy many, fowls some.—[Heath.

Vicksburg, Renville County.—20. 1873.—[Hale.

Worthington, Nobles County.—21. Blackbirds, wheat-birds, blue, lake-gulls, prairie-chickens, ducks.—[McDowell.

Fairmount, Martin County.—20. 1873, 1874, 1875, 1876, 1877. 21. All kinds of the feathered tribe, both tame and wild, eat all they can.—[Bullard.

Moorhead, Clay County.—19. Had a most numerous visit in 1876. 20. 1863, 1864, 1865 (1865 little damage done), 1866, 1867, 1869, bad in few places; 1870, 1871, 1872, bad; 1873, 1874, 1875, 1876. 21. From the crow down to the little wren they are useful.—[Unknown.

Otto, Pope County.—20. 1871, did little injury.—[Hoffman.

Oak Lake, Becker County.—19. Flew in. 20. Came in 1871; deposited eggs which hatched in 1872; in 1874, hatched in 1875; again 1876. 21. Domestic fowls, crows, blackbirds, and grouse, do good work.—[Unknown.

Swansea, Renville County.—20. 1864; 1874 latter deposited eggs.—[Davis.

Alexandria, Douglas County.—20. July 1, 1871. 21. Very little.—[Unknown.

DAKOTA.

Sioux Falls Post-office, Lincoln County.—19. Our county had its full share in 1876. 20. 1874. 21. They are destroying a great number.—[Jacobs.

Springfield, Bon Hommé County.—20. August 3, 1872; 1874, 1875, 1876.—[Hitchcock.

Willowtown, Armstrong County.—19. Was. 20. 1875. 21. All feathered tribes seem to destroy them.—[Taylor.

Forestburg, Bramble County.—20. July 25, 1876; July 12, 1875.—[Santee.

Dell Rapids, Minnehaha County.—19. Crops almost entirely destroyed. 20. 1874.—[Hill.

Madison, Lake County.—20. July 17, 1874; July 19, 1875; July 14, 1876.—[Law.

Bon Homme, Bon Homme County.—19. It was visited. 20. Beginning with 1858, and every year since. 21. Domestic fowls have destroyed many; birds have destroyed more than all other animals.—[Bradford.

Saybrook, Clay County.—19. In the fall, very numerous and deposited eggs. 20. Six years out of nine; increasing every year. 21. All kinds of birds and fowls.—[Hall.

Walhalla, Pembina County.—19. We were not visited last year. 20. Every year from 1863 to 1875. 21. Prairie chickens feed on the eggs; their crops, on being opened, appear to contain nothing but locusts in their season; domestic fowls, pigs, and toads feed on them.—[Mayer.] 20. 1875 and 1876. 21. Slight.—[Unknown.

Sioux Falls, Minnehaha County.—21. Birds have destroyed myriads; many fields having been kept clean.—[Everett.

Sioux Falls, Minnehaha County.—19. This section was infested in 1876. 20. They flew over thickly the three previous years, but did serious damage only once.—[Clarke.

Jamestown, Stutsman County.—19. July 12, 1876. 20. About July 21, 1875. 21. In this section blackbirds.—[Moore.

Sioux Falls, Minnehaha County.—19. Was visited, but very little harm done. 20. August, 1875; July, 1873; September, 1871. 21. Birds, &c., prove very destructive, but do not seem to visibly affect the number. At this time (May) the young as fast as hatched are devoured by birds, &c. The birds will readily follow a team all day, going over breakings where the team disturbs the eggs.

Spring Valley, Turner County.—19. It was. 20. In 1874 and 1872.—[Andrews.

Olivet, Hutchinson County.—19. It is the only year in which damage has been done. Came from the north, and stayed 20 days.—[Jones.

APPENDIX XXII.

MISCELLANEOUS NOTES FROM MINNESOTA.

Saint Paul.—I find that I can add another grasshopper year to the Minnesota list, *i. e.* 1866. It was not a visitation, but simply an appearance. They passed over a town in Kandiyohi County, and stopped over for one night; left the next day, and nothing more was heard of them in this place. They were also seen in nearly the same way at or near Redwood Falls. Probably these were only some stray swarm of the invasion of that year, and though it amounts to nothing as an "invasion," goes to swell up the facts in regard to the general state of the case.

I have been expecting to alight on something that would show the appearance of locusts here in 1867, but so far I have found nothing. The invasion was so close to us (in Iowa) that probably swarms passed over Southwest Minnesota; but the country was unsettled then.

Mr. C. H. Bates, a surveyor living at Yankton, writes, January 28, 1878:

"Since receiving your letter, I have examined files of our local papers, and find no mention of them (locusts in 1873). Taylor (editor of the Herald) tells me that it was an understanding between the papers to make no mention of them that season. The grasshoppers *were* here that year, but did not do much damage. I have talked with several of the farmers in this vicinity, and find their memories are a little conflicting as regards events that year, but all say they were here. From information received, I will say: Grasshoppers were here during the summer of 1873, and damaged the crops somewhat, as near as I can learn, in sections or streaks, that is, in some localities they did considerable damage, while in others they did none. The wheat was most all harvested; and I see that the papers reported the crop good, both as regards quantity and quality, and, the papers say, better than in 1872. Corn and oats were but part of a crop; in some sections it was all taken. The first flying of the grasshoppers was from the northwest to southeast, about the 4th of July. No eggs were deposited; and, in fact, none, to any extent, ever have been, except in the summer of 1876. I mean by the above that no eggs were deposited within the settlements in Southeastern Dakota. In the central part, some hatched in 1874."

On further inquiry as to this latter statement, Mr. Bates adds: "The sand-hills of the Cheyenne of the North, and west of the Missouri River, near the west boundary of the Territory, about the 46th parallel of latitude. This I get from a man who was in that country in 1874."

From what Mr. Bates says in regard to the injury—slight to wheat and severe to oats and corn—I should judge that the visit in Dakota Territory that year was later than in Minnesota and in Iowa, and I believe I have already told you that Mr. F. J. Cross, immigration agent, said that a few eggs were laid near Yankton in September. But, though they did appear early in June in Minnesota and in Iowa, they kept coming, were going north over Jackson, Minn., on the 2d of August, and came into some Iowa counties in August—Harrison, for instance.

In regard to Iowa, I have now reports:

1857, 1858.—Ida, Harrison, Pottawattamie, and Montgomery Counties.

1858, 1859.—Woodbury County.

1864, 1865.—Woodbury County.

1867, 1868.—Dickinson, Kossuth, Sioux, Palo Alto, Plymouth, Buena Vista, Pocahontas, Humboldt, Ida, Lac, Calhoun, Webster, Hamilton, Carroll, Greene, Boone, Harrison, Audubon, Guthrie, Cass, Adair, Warren, Montgomery, Union, Page, and Ringgold Counties.

1868, 1869.—Woodbury, Crawford, and Pottawattamie Counties.

1874.—Hatched in the counties of Lyon, Osceola, Dickinson, Emmett,[1] Kossuth,[1] Sioux,[2] O'Brien[2] (eggs deposited in June 4, 1873, and hatched same year), Plymouth,[2] Pocahontas, Humboldt, Wright (in west half), Woodbury, Lac, Calhoun (many in north half), Webster, Monona (?), Harrison, Pottawattamie,[1] Mills,[2] Montgomery, Union (a few). Often appeared to be about the east limit in that latitude.

[1] In very great numbers. [2] In very small numbers.

1875.—Hatched in the counties of Lyon[2] (?), Palo Alto, Plymouth,[2] Wright (a few in west half), Guthrie, Cass (?), Mills,[2] and Fremont.[2]

1876.—Hatched in the counties of Lyon (?) (few), Osceola,[2] Plymouth,[2] Wright (a few in west half) (?), Crawford, Audubon,[1] Cass,[1] Mills, Montgomery, Fremont[1] (?), Page, and Taylor (in west half).

1877.—Counties of Lyon,[1] Osceola,[1] Dickinson, Emmett,[2] Kossuth, Winnebago, Worth,[2] Sioux,[1] O'Brien (?), Clay, Palo Alto (no damage), Hancock, Plymouth, Buena Vista, Pocahontas,[2] Humboldt, Wright (in west half), Woodbury,[1] Ida,[1] Lac, Calhoun,[1] Webster, Hamilton, Monona, Crawford,[2] Carroll,[1] Greene, Boone, Story (in northwest corner), Harrison, Guthrie, Dallas (in northwest corner), Pottawattamie, Cass,[2] Adair,[1] Madison (in northwest quarter), Mills, Montgomery,[2] Adams,[1] and Page.[2]

Mitchell County.—None hatched here.

Cerro Gordo County.—None ever hatched here. Eggs were deposited in 1876, but did not hatch.

Floyd County.—Never troubled.

Brewer County.—Some people thought they saw them flying over Waverly in 1877.

Hamilton County.—None between 1868 and 1876.

Hardin County.—None ever hatched here; never troubled. But I picked them up last September at Ackley, in the northeast corner of the county (some, then, evidently alighted), and a farmer passing told me that they were thicker out in the fields than they were in the spring.

Grundy County.—None ever hatched here, but flew over Grundy Center in 1877.

Black Hawk County.—Some people thought they flew over Waterloo in 1877.

Greene County.—Have been with us more or less since 1867. In some years but few, however.

Story County.—Never hatched until 1877, in northwest corner. Professor Bessey says they were at Ames in 1867, 1874, 1875, 1876, and 1877; in 1873 and 1874 a few specimens, considerably more in 1875, while in 1876 they were abundant. Hatched in 1877, but did not amount to much.

Marshall County.—Flew over Marshalltown in 1877.

Tama County.—Flew over Toledo in 1877.

Benton County.—Some thought they flew over Vinton in 1877.

Jasper County.—None came here.

Poweshiek County.—Flew southwest over Montezuma in 1877.

Warren County.—Came in 1867, and a few have been hopping about ever since; no damage since 1867 and 1868.

Marion County.—None.

Clark County.—None.

Lucas County.—Have never had them; have resided here since 1857, and think I should have known it if they had ever done injury here.

Monroe County.—Have never had them.

Ringgold County.—In 1867, 1868. None have hatched since 1873.

Decatur and Wayne Counties.—None hatched here since 1873.

I thought at first that 1868–'69 must be a slip of memory for 1867–'68, but my reports from Woodbury and Pottawattamie Counties are very carefully written, evidently, and are probably correct; that from Crawford County is very brief, but may be correct also.

I was considerably surprised to find that there was so much hatching in Iowa in 1876, but I think the reports are correct, because the writers go on to speak of the occurrences of 1877; and in several cases these eggs appear to have been laid by *swarms moving up from the south in June*. But the statements are generally so brief that it is hard to say exactly what is meant, and I do not know how good authority the writers have.

N. B.—It seems to me that considerable work was left undone last summer in the way of collecting facts. So far as I am concerned, I am sorry that I didn't have my work mapped out better, but that was my fault.

In regard to 1877, what Professor Bessey says about damage to crops is confirmed from almost every county. Out of the whole list there are only two or three that admit serious injury, while most of them report that the young largely failed to hatch, or where they were numerous failed to prove as destructive as formerly.

I am sorry I did not have all this to send to you a month ago, but some of it has just come in. I have written to some counties three times, first to county auditors, then to clerks of courts, and lastly to postmasters, and in this way have got some kind of a reply from almost every county.—[Allen Whitman.

Saint Cloud.—I have seen and conversed with many of the old residents of Stearns County—Americans, Irish, Scotch, English, and Germans—and as I speak the German sufficiently to hold conversation in that language, I have used it with the last nationality, so that there should be no mistake in their understanding me, and they are nearly

[1] In very great numbers. [2] In very small numbers.

all positive that the grasshoppers came in 1856, deposited their eggs that year, and hatched and left in 1857. A few rather thought 1855 and 1856 were the years, but they were by no means positive. I was a resident of Saint Paul in all of the years above named, and recollect distinctly that in 1856 we had the news of a serious invasion of the upper country by the 'hoppers. In 1862 they came also in vast numbers as far south and east as the old crossing of the Ottertail River. I was at the time in command of mounted troops, escorting a train of supplies for Fort Abercrombie, and about twelve miles on this side of the fort they alighted, while we halted for dinner, in countless millions, and began an indiscriminate attack on everything eatable, even to our saddle-blankets. I believe they left without depositing their eggs, however, but of this am not positive. From very reliable and quite disinterested information I am sure your assertion as to the years 1856 and 1857 is correct. As to the flies, they were the flies described in your bulletin as the Tachina fly. Some two or three weeks before the final flight of the 'hoppers I noticed thousands of those flies on my timothy and clover meadow, where the locusts were in great numbers, and noticed that they seemed to be in fear, restless, and uneasy. I found by watching that they had cause to be, for no sooner would one take wing, or even hop, but he would be attacked by those flies. Finally the locusts rose *en masse* and left, and shortly after (I have now forgotten how soon) the flies left in a cloud or swarm, nearly all. I saw the locusts leave, also the flies. Then, about the last flights of locusts going southeast, or shortly after, I saw at two different times, on different days, flights of what I believed, and still believe, were the same flies before spoken of. My neighbor, Donald McIntosh, also saw one, if not more, swarms of these flies, apparently following the locusts. In every instance they (the flies) took the same course as the locusts.—[J. I. Salter.

Sibley, Sibley County.—They have visited us in the years 1857, 1858, 1864, 1865, 1874, 1875, 1876, and 1877. When there is no wind they fly about 8 or 10 miles an hour, but when going with the wind they move much faster. They only fly three or four hours in the mid le of the day.—[C. E. Woodbury, July 8, 1877.

Marshall, Lyon County.—Mr. Lorenzo Lawrence, of Yellow Banks, an educated Indian, who is fifty-five years old, and less reticent than most Indians, was here last week. He says the 'hoppers always came into this country occasionally since his infancy—he thinks once in three to five years; generally laid eggs, and the next year flew away westward, and no more was seen of them till three or four years after. But since crops are sown here they like grain, and do not return as before, but fly only a few miles—say, from 20 to 100 or 150, settle down and breed, and the hatch of the following year go no farther than to where the parents hatched.—[D. F. Weymouth, July 18, 1877.

Collins, McLeod County.—When the wind changes the young 'hoppers seem to hop against it for the period of twenty-four hours, and then in every direction until another change takes place. * * * In 1874, July 4, the first 'hoppers I ever saw alighted here. While I was in the Army, in 1865, some were hatched here. There were very few settlers here at the time and I cannot learn much of their history. Commenced depositing eggs July 25, 1874, hatched in May, and left mostly July 9, 1875, forty-nine days after hatching. Arrived here July 17, 1876, and commenced laying July 20, and kept at it two months. Travel from 4 to 20 miles per hour; usually fly from 9 a. m. to 4 p. m., but when two or three nights pass without dew collecting mature 'hoppers will frequently fly in the night. There is no habit that is not abandoned at some time during the season.—[G. C. Canfield, June 14, 1877.

Herman, Grant County.—The 'hoppers came here last year on the 4th of July, stopped two days, and proceeded in a southeast direction. They came again in the latter part of the same month and stopped several weeks; deposited their eggs everywhere. *They did not fly here in either case, but came on the ground.*—[Thos. C. Hodgson, June 22, 1877.

Orr, Jackson County.—Answer to question 20. August, 1864; June, 12, 1873. Eggs laid both years.—[Jared Palmer, June 18, 1877.

Dewald, Nobles County.—I have sown a varied assortment of farm seeds for the past five years, and know of but one crop that is free from their attacks, viz, peas. Sorghum will escape pretty well if it has attained large size before it is attacked. Some of the neighbors have a hard-strawed variety of wheat—*Red Osaka*—which suffered less than the *Fife*, although it is by no means proof against them. * * * After they are a month or so old they have a habit of getting off to the low-land, ravines, banks of streams, timothy meadows, &c., and remaining there till they get their wings; they then congregate in swarms and raid on the crops. Pease and horse-radish are the only cultivated plants I am acquainted with that they won't eat; and, among wild plants, cockleburr, purslane, and helianthus, seem to be exempt, but the native grasses are eaten by them when they can get nothing to suit their palate better. Raiders (invading swarms) always attack oats first, then flax, corn, wheat, and potatoes, in the order given.—[David Bates, June 13, 1877.

Dassel, Meeker County.—The 'hoppers came here August 1, 1876; not visited in any previous year except 20 years ago I am told they were here, but cannot obtain any reliable information concerning their depredations at that time. Young 'hoppers congregate at sunset in groups or bunches at the foot of fence-posts, under sides of logs,

at roots of stumps, by the sides of buildings, &c., and remain quiet. When larger they climb upon fences, buildings, trunks of trees, &c. The full-grown 'hoppers also climb the stalks of grain, small bushes, fences, buildings, &c., during night. Sometimes they eat during night, at othertimes they remain quiet. I have known them to eat the weatherboards in my house in one night so that it looked like newly planed lumber. * * * Young 'hoppers never march during night, but I am of the opinion that the old ones fly all night some nights.—[S. W. Maxson, August 1, 1877.

Burnhamville, Todd County.—Among wild birds useful in destroying the young and fledged insects is, first, the prairie chicken or grouse, the crow robin. Of the domestic fowls, ducks and hens are the most effective. I had 150 young and old turkeys, ducks, and hens; constructed light coops that could be moved and kept the fowls out night and day; were only supplied with water. Twenty chickens or ducklings when two weeks old at the time the 'hoppers begin to hatch, will clear out one acre however thick the eggs were deposited. Eggs were deposited on about 20 acres of my farm and 'hoppers hatched accordingly. With tar and fowls I save almost the entire crop, but the latter were my chief reliance. Kept them in the grain till the 'hoppers left—about the fifth of July. I am confident that a twenty or thirty acre field can be saved by a farmer if he provides for poultry in season. The young should be about two weeks old when the first 'hopper eggs hatch. The ground must be plowed in the Fall or Spring so they will hatch gradually.—[Albert Rhoda, August 24, 1877.

New Auburn, Sibley County.—Locusts flying 22d June, and almost daily since from 9 a. m. to 4 p. m., mainly from the southeast, but sometimes from north and northwest from from 5 to 40 miles per hour, averaging, probably 15 miles. Temperature 70° to 90°; weather clear, sometimes scattering clouds. I can scarcely give an idea of the density; apparently like a heavy snow-storm; height from 100 feet to as far up as the eye can reach; to protect the eyes and look toward the sun, seemingly one mile, at least as high as a bright object of that size can be seen with the naked eye, and, probably, much higher.—[S. S. Clevenger, July 8, 1877.

Becker, Sherburne County.—Were visited in 1856. The 'hoppers did not act (in 1876) as they did in 1856, for then they did not begin to lay until the nights began to get cold; but this time they began to lay next day after they arrived.—[John A. Wayner.

Banks, Faribault County.—I had a garden of four acres covered with 'hoppers. I hatched about 100 turkeys and chickens; in two weeks they had cleaned them out.—[Wm. O. Payne, July 21, 1877.

Excelsior, Hennepin County.—Had 'hoppers in 1856; left 1857, having damaged spring wheat, but not much winter wheat.—[T. Bost.

Medalia, Watonwan County.—'Hoppers visited us July 3, 1873. In 1874 hatched and destroyed nearly all crops. Came in 1875, July 9. In 1876 hatched and did great damage; also visited us in immense swarms from northwest August 18, which laid eggs.—[C. C. Sylvester, June 16, 1877.

Grafton, Sibley County.—July 1, 1877, at noon, 'hoppers in great numbers fill the air from 20 rods high to just as high as the eye can see them; seem to be going southwest, as the wind is northeast. They fly at all times just the way the wind blows. The weather is very warm; the upper current of air is very mild; 'hoppers moving very slow, while the lower current is a little stiffer, and, consequently, the lower 'hoppers are moving much faster than the higher ones.—[Geo. R. Gardner, July 2, 1877.

Eagle Lake, Blue Earth County.—In answer to question 20 I can say we were visited by the grasshoppers the Fall of 1874. They laid eggs and died with us. The spring of 1875 they commenced hatching out about the 20th of May; on the 25th of May I wrote in my diary "grasshoppers very thick"; again May 31, "'hoppers very thick, some think they will take everything." They did us but very little damage and went away without laying any eggs. It was in May, that summer, that Blue Earth County paid out over $30,000 within ten days for grasshoppers. No one here believes that our crops were saved by that operation. It distributed that amount of money among the people who actually needed it, and that is about all the good we can see that it did. It is worse than folly for any county or even State alone to attempt by paying a bounty to destroy the 'hoppers, and by that means expect to save their crops. It would bankrupt the State to pay ten cents a bushel for grasshoppers this year.—[Ira B. Reynolds, June 15, 1877.

Marshall, Lyon County.—When flying high in the air old locusts always go direct with the wind, but often beat up against the wind, or at some angle of it by short flights near the surface. In 1865, July 13, a large caravan passed across my claim going west in the teeth of a strong northwest wind. The advance was two days ahead of the rear guard, and between them there was, at least, a grasshopper to the square inch all the way, and all the time. I do not think they went quite a mile an hour, and they eat all in their way, and left the country as soon as the wind changed to the southeast. They had been hatched in the lower valley of the Redwood, and eaten it clean, and started west for food and pressed on as fast as the winds would admit, and when they could not fly in the usual way they flew as far as they could, and then flew again, feeding as they went. The same swarm of locusts will fly in every direction, short flights.

I have most satisfactory evidence that they have flown from the north part of Lyon County to Lake Benton—say 40 miles—one day, and returned to the central part of Lyon County the third day, and after remaining a day or two gone east and not returned.

They do not fly high in cloudy weather, but will go from one wheat-field to another. Do not fly in hard winds, and never are seen flying except between 8 a. m. and 7 p. m., generally from 10 a. m. to 4 p. m. If they fly nights no one knows it. If they go to roost they are in the same spot next morning, and do not move till they breakfast and the dew is all off. They only float with the wind when flying high, and go just as fast as the wind blows. With a strong glass I can plainly see locusts and cottonwood seeds flying together, and they keep the same rate of progress, but the locusts will leave the cottonwood seeds to the right and left, and go below and above them, showing that they make use of their wings to keep up and gyrate in flying, but I think they propel ahead none at all after they get high, but fly forward and upward very fast when rising from the ground to fly away, or for short flights.

As to how far they fly, I have no reliable data, nor much basis for an opinion. But we can, at least, judge pretty certainly the age of a locust; for a locust breeds but once, never couples until it has flown, but does directly after, doing his courting flying, and does not live long after it lays its eggs. So we can judge by their age in what latitude they hatched, and by that give a good guess how far they have traveled. Now, those that came here in 1873, June 17, began to couple as soon as they lit. They hatched and came to the winged state far south of this, and came here pretty rapidly. Last summer flights came here in August (I cannot fix date), and began to couple as soon as they alighted. We could trace them back by telegraph as far as Manitoba. I believe they came from the Saskatchewan Valley and hatched after the middle of June. I think they fly above the limits of human or telescopic vision, in long journeys, and it may be day and night, for a thousand miles.

As to preference in food the locust, while willing to eat anything, is really epicurean; but of all things, they love the tender leaves and new wood of maples, poplars, ash, box-elder, bass, currant, and raspberry; lilacs they will eat to the ground, and kill rhubarb and asparagus of large growth; pepper, tobacco, mustard, cabbage, turnips, celery, beets, carrots, spinach, parsley, and lettuce they generally take clean; beans, they are fond of; corn, they do not like so well as tender prairie-grass till about silking, then they are very fond of it. They eat barley, rye, wheat, oats, and flax about alike; some seasons they seem to eat wheat more, some oats more, according as one is more tender than the other when they arrive. Vines—cucumbers, melons, pumpkins, &c., they let alone generally; also potatoes, tomatoes, and pease, but will eat any of them if hard pressed.

I think all birds eat some grasshoppers, but ducks, partridges, quails, and prairie-chickens, are so much vegetarians that I seldom find a grasshopper in their craws. Crows, blackbirds of all stripes, snipe, plover, king-birds, ground-birds, pigeons of all kinds, geese, cranes, turkeys, and common fowls destroy great numbers. The fancy hens are too lazy to catch them. Ten turkeys and their young will keep a ten-acre lot free from grasshoppers; I have tried it successfully. But in this country frogs are very numerous, hatching in the "sloos," and going into ponds, lakes, and streams as the "sloos" dry out, and they kill more grasshoppers, ten to one, than all the birds (?). I have seen a frog in the twilight in my door-yard eat 5 large locusts in 8 minutes; and he kept it up all night for all that I know. Skunks eat them.—[D. F. Weymouth, July 7, 1877.

Sauk Rapids, Benton County.—The section I live in has not been troubled with grasshoppers since I have lived here—that is since 1870. This is a timbered section and they do not appear to thrive in it. On 13th August, 1874, a great many came from the northwest and deposited eggs, but there was very few of them hatched out the following spring. There is a regular flight of them from the northwest to southeast from about the first week in August until about September 10, every year since the date first mentioned.—[James McCulloch, June 18, 1877.

Morristown.—I have watched probably twenty egg-masses go through the process of hatching. They all cast off the outer shell before any leave the cocoon; and with their bodies and long legs covered with a translucent film, opened in front, with their heads and fore legs protruding they writhe and press the foremost individual against and through the covering of earth. So badly is the first one punished by squeezing that it is sometimes the last of the lot to make a jump. After the first, the others quickly follow by the wriggling, moving their heads to and fro and pushing with their short fore legs. As they emerge from their cells and reach the surface of the ground they tip over sidewise or upon their backs, and by the motion of their bodies and restrained legs, helped by the legs and feet that are free, they slide this gown, which restrains them, backwards; when it has approximated the posterior extremity they whop over upon their faces and make a jump. By this first jump, if successful, they are freed from this gossamer sack, and are entirely at liberty. If the first attempt fails they try another jump, and until they become free. The sacks (the thin white

coverings) are all left (from one cocoon) on a spot of earth not larger than a fifty-cent piece, and look like diminutive mushrooms, so neatly are they folded back and arranged by the young locusts as they disrobe themselves.—[D. L. B. Coe, June 14, 1877.

Clear Lake, Sherburne County.—Early crops stand the best show with the 'hoppers, for the reason that the early crops get a start and get tough before the 'hoppers are large enough to eat much. I notice that those that planted early, their crops are not being damaged near as much as those that planted late. It is not best to work the crops so long as the 'hoppers are in them. I have twenty-four acres of corn. The land on which it was planted was very weedy last year. I planted my corn the 15th of May, and now there is not a weed to be seen on the whole piece. The corn has not been eaten but very little, but the weeds have been eaten as fast as they came out of the ground. I have information from those that were here twenty years ago that those that worked their crops lost them, and those who did not saved them.—[Daniel Frye, June 11, 1877.

Mankato, Blue Earth County.—One remarkable fact is observable: that the 'hoppers frequent the woods, and are generally found quite thick in timber. Never observed this before. In cases, have left grain-fields and taken to the timber.—[John C. Wise June 6, 1877.

APPENDIX XXIII.

ARE THE EGGS OF THE ROCKY MOUNTAIN LOCUST LAID THICKLY FOR TWO CONSECUTIVE YEARS IN THE SAME LOCALITY?

[Have you ever known the eggs of this Rocky Mountain locust to be thickly laid for two consecutive years in the same ground or in the same locality? Answers to the above question sent out by Mr. Riley.]

ARKANSAS.

Bentonville, Benton County.—I have not.—[J. W. Williams.]
Carrollton, Carroll County.—No.—[John L. Sims.

COLORADO.

Colorado Springs, El Paso County.—Cannot answer from personal observation.—[H. McAllister.

Denver, Arapahoe County.—Yes. No. 3. In 1874, 1875, and 1876 they laid their eggs very thickly on my farm and in its immediate vicinity, three years in succession, and in the same breeding-spots.—[C. L. Campbell.

Fort Collins, Laramie County.—For three years, on my farm, have they propagated luxuriantly.—[R. Q. Tenney.

Georgetown, Clear Creek County.—Eggs have been laid for two consecutive years in the same locality, but whether in the same ground exactly I cannot say.—[H. W. Pollitz.

Greeley, Weld County.—The eggs of the locust have been thickly laid in this vicinity for two consecutive years. In the fall of 1875 and of 1876 eggs were laid, and in the spring of 1876 and of 1877 the young hatched in such numbers as to destroy, or to be able to destroy if left alone, crops in many parts of this valley (Cache Le Poudre) and on the Saint Vrai, and Boulder Creek, in Boulder County. I speak from personal observation.—[G. B. Hight.

Howardsville, San Juan County.—In certain warm, sandy spots along the Animas River, I have noticed eggs laid and locusts hatch out for three successive seasons. Perhaps, however, they were not true migratory locusts.

La Porte, Larimer County.—Yes; three years in succession (1875, 1876, 1877).—[E. N. Garbutt.

Larkspur, Douglas County.—I think not.—[W. R. Leverson.

Pleasant Valley, Fremont County.—I have not.—[S. C. Brown.

Pueblo, Pueblo County.—I have not.—[Judge Hallett.

Saguache, Saguache County.—No.—[W. B. Felton.

Wheatland, Larimer County.—I have. They generally lay each year on the same knolls, especially if it is sod ground, and there is anything on which they seem to love to feed near.—[J. C. Abbott.

IOWA.

Algona, Kossuth County.—They have never deposited eggs here two years in succession.—[H. C. McCoy.

Alta, Buena Vista County.—No; I have not.—[Crowell & Thompson.

Ames, Story County.—I have not; but I am on the very edge of the locust region, and have seen comparatively little of them.—[C. E. Bessey.

Athol, Sioux County.—I have not.—[W. J. Newell.

Chickasaw, Chickasaw County.—Not thickly.—[William Tucker.

Council Bluffs, Pottawattamie County.—No. I have resided here twenty-five years, and have been visited by locusts several times, but I have never known them to lay eggs for two consecutive years in the same ground.

Denison, Crawford County.—I have not.—[M. H. Wygant.

Des Moines, Polk County.—Eggs have never been laid thickly for two consecutive years, so far as I am able to ascertain.—[William H. Fleming.

Le Mars, Plymouth County.—I have no personal knowledge that the eggs have been laid for two consecutive years in one locality, though it is said to have occurred in some counties in Minnesota.—[J. M. Jenkins.

Little Sioux, Harrison County.—I have never known of their having been thickly laid, but have known them to be sparingly deposited by other swarms coming in from the north-northwest; but the swarms coming in the second season are always small.—[A. H. Gleason.

Sidney, Fremont County.—Never knew the same ground with any eggs two consecutive years.—[G. V. Swearingen.

Sioux County.—No; I have not.

Sioux City, Woodbury County.—I have observed the grasshoppers in this locality ever since 1857, and have never known it to be the case.—[Wm. R. Smith.

Tabor, Fremont County.—No.—[J. T. Sanborn.

Spirit Lake, Dickinson County.—In this county they did not lay their eggs any two years in succession, but I am informed they did in part of Jackson, Nobles, Rock, Cottonwood, and some other counties in Minnesota. Some residents of this town inform me that they deposited eggs in the above-named counties in 1873, 1874, 1875, and 1876; others say 1874, 1875, and 1876, and others 1875 and 1876. I am inclined to think that 1874, 1875, and 1876 is correct.—[Emmet T. Hill.

Webster City, Keokuk County.—So far as my observation extends, the 'hoppers have not deposited their eggs here during any two consecutive seasons.—[C. Aldrich.

West Liberty, Muscatine County.—No.—[E. H. King.

Onawa, Monona County.—Yes; I have. In 1867, the deposit of eggs in this county was universal, and the ground was literally filled with them. In 1868, the 'hoppers returned from the north, and in some localities in this county again deposited eggs so thickly that the young 'hoppers in 1869 destroyed the spring grain in some places and badly injured it in other places. I desire to say that here the full-fledged 'hoppers uniformly travel north up to the middle or 20th of July, and uniformly travel south after that time.—[Addison Oliver.

Sac City, Sac County.—Have never known them to deposit eggs here two consecutive years.—[Washington Allen.

Shelby, Shelby County.—No.—[W. H. Brown.

Sheldon, O'Brien County.—No.—[J. C. Elliot.

Sidney, Fremont County.—Our observations extend back some twenty years, and we never knew eggs to be deposited two years in succession.—[G. V. Swearingen.

KANSAS.

Atchison, Atchison County.—Personally I have not. I think the eggs of this insect have never been laid to any extent the year following the first hatching among us in any part of our State, at least in the inhabited parts.—[H. P. Stebbins.] In 1866 and 1867 eggs were deposited in great abundance in the same localities; but the last crop did not hatch out very good, and were not very destructive when they did hatch.—[C. W. Johnson.

Belleville, Republic County.—No; I have not.—[J. P. Heaton.

Burlington, Coffey County.—A few in 1867 and 1868.—[B. L. Kingsbury.

Chanute, Neosho County.—No.

Cherryvale, Montgomery County.—I don't think they ever laid eggs two years in succession in this country.—[C. G. Brooks.

Claytonville, Brown County.—In the past ten years we have been four times visited by locusts. In the fall of 1867 they came and laid a few eggs. In August, 1868, they came again in greater numbers, and laid their eggs, which hatched and did much damage in 1869. In August, 1874, they came again in still greater numbers, and left their eggs, which hatched in 1875 and devoured almost everything. In September, 1876, they came thicker than ever before, and deposited their eggs so closely that in many parts the ground was covered; but the wet Fall and spring destroyed the eggs, and they did but little damage. I have not seen eggs in the same ground or locality for two consecutive years.—[William M. Robertson.

Ellis, Ellis County.—Have not observed particularly; but think not.

Elivon, McPherson County.—No.

Farland, McPherson County.—They have never laid eggs in this county till last fall.

Geneva, Allen County.—I have not.—[Van Deman.

Great Bend, Barton County.—Have never known them to deposit eggs in same locality for two consecutive years in this section of the State.—[D. J. Evans.

Hiawatha, Brown County.—Negative answer from all I have put the question to.—[E. M. Pratt.

Industry, Dickinson County.—No; nor has any one about here.—[G. J. Smart.

Iola, Allen County.—I have not.—[H. T. Rice.

Irving, Marshall County.—Several old settlers here tell me that in both the Fall of 1866 and 1867 grasshopper-eggs were thickly deposited in some localities in this district, but the latter year they soon disappeared, after hatching in the spring, doing but little harm.—[B. P. Ward.

Junction City, Davis County.—No; I have not.—[Charles S. Harris.

Lane, Franklin County.—No.—[James Hanway.

Lawrence, Douglas County.—No; and I have been here twelve years.—[George F. Gaumer.

Leavenworth, Leavenworth County.—I have not. They were laid here in 1867, hatched out 1868, laid again in 1874, hatched out in 1875.—[J. A. Haldeman.

Logan, Phillips County.—I have never known them to deposit eggs two successive years in this locality; but they deposited eggs two years in succession on my farm in Cottonwood County, Minnesota.—[John Benjamin.

Manhattan, Riley County.—I think not, but am not sure.—[N. A. Adams.

Millwood, Leavenworth County.—I have not.

Neosho Falls, Woodson County.—The eggs of the locusts were laid in the years 1875 and 1876, some three or four miles from this place, upon an extensive plowed field of Thomas Herdman, and on a number of other farms near or in the same ground in these consecutive years.—[J. T. Goodnow.

Newton, Harvey County.—Have never known them to lay eggs for two consecutive years in the same locality.—[T. L. Knott.

Norton, Norton County.—No; and I observed them ten years ago in Northwestern Iowa; six years ago in Jefferson County, Nebraska, and four years here.—[Thomas Beamont.

Oakwood, Linn County.—No.—[W. E. McIntire.

Olathe, Johnson County.—No.—[E. P. Diehl.

Osborne City, Osborne County.—I have not.—[M. Mohler.

Oswego, Labette County.—No. I have not.—[F. B. Abbott.

Ottawa, Franklin County.—No. No. No. Quite a large number of eggs were deposited in the autumn of 1876, in the same localities that had received the deposits of 1874. These, however, generally came to nought in the egg, and the rest, as I have stated, were destroyed after hatching. Eggs have never been deposited two years in succession in our part of the State.—[H. J. Smith.

Parsons, Labette County.—No. No.—[Anzell Mathewson.

Russell, Russell County.—I have not.—[Dr. H. A. Ellis.

Salina, Saline County.—Yes; they laid eggs for three consecutive years in Idaho Territory—1866, 1867, and 1868.—[A. G. Whitney.

Salina, Saline County.—Have not known of such an instance, and cannot learn of any.—[S. J. Gilmore.

Spring Hill, Johnson County.—No.—[H. Perley.

Tabor, Clay County.—No.—[J. W. Bagby.

MISSOURI.

Bigelow, Holt County.—Yes; I think in the fall of 1866, the fall of 1867, and I believe the fall of 1868.—[J. H. Crow.

Carthage, Jasper County.—Never knew them to be laid two consecutive years in any quantity in the same locality. No.—[J. Tilden.

Defiance, Worth County.—I have not.

Doylesport, Barton County.—I think I am safe in assuring you the locusts have never settled or deposited their eggs for two consecutive years in this county, Barton.—[J. J. Bryning.

Forest City, Holt County.—Never knew them to lay eggs two consecutive years in the same ground.—[J. W. White.

Flag Spring, Andrew County.—I have never known them to do so.—[J. K. White.

Golden, Barry County.—They never laid here but once that I know of.—[W. F. Tuttle.

Greenfield, Dade County.—No.—[R. A. Workman.

Lamar, Barton County.—No. No.—[William H. Avery.

Little Osage, Vernon County.—The locusts have visited this section three times in ten years, and, as far as my observation goes, have deposited eggs in the same ground, or nearly so, but not for two consecutive years.—[M. L. Modrell.

Morrisville, Polk County.—I have not.—[J. M. Loafman, M. D.

Mount Vernon, Lawrence County.—I have never known them to be laid in same ground two successive years. No.—[John Cecil.

Oregon, Holt County.—No; I have not. A path over which it was my daily habit to pass was filled with eggs each fall, and they hatched in the spring afterward. Some vacant lots near my residence, which are annually covered with dog-fennel (*Maruta cotula*), were always filled with eggs in the fall and young in the spring.—[J. W. Maple.

Pickering, Nodaway County.—There has never been an instance of their laying for two consecutive years in this county.—[M. B. W. Harman.

Rochester, Andrew County.—I have not.—[J. Kimbertin.

Rockport, Atchison County.—No; I have not.—[Jno. D. Dopf.

Reeds, Jasper County.—No.—[J. M. Thornburg.

Sarcoxie, Jasper County.—No.—[Thomas McNallie.

Seneca, Newton County.—In an experience of twelve years, no.—[W. H. Wetherell.

Stockton, Cedar County.—No.—[J. W. Montgomery.

MINNESOTA.

Janesville, Waseca County.—I have not.—[J. J. Headley.

Luverne, Rock County.—I have; in 1875 and 1876 they deposited their eggs in the same ground and in the same locality.—[H. Brockway.

Minneapolis, Douglas County.—Yes, thickly, two years in succession in same ground.—[D. C. Bell.

NEBRASKA.

Amazon, Franklin County.—I have not.—[H. O. Hendricks.

Brownville, Nemaha County.—Have never known eggs laid for two consecutive years in same ground in same locality. Have been here now twenty-two years.—[Rob. W. Furnas.

Jewett, Salem County.—I have never known the eggs of the locust to be laid for two consecutive years in the same ground or locality.—[W. F. Ware.

Genoa, Platte County.—Although I have seen the locusts for several years, I have never observed them deposit their eggs before last year.

Hendricks, Otoe County.—No; not in a residence of one score years here.

Johnson, Nemaha County.—I have not.—[J. B. Johnson.

Nebo, Platte County.—I do not believe there are a thousand eggs laid in Platte County this fall, and never knew of them laying eggs two years in succession in the same locality or ground to any extent.—[John Wise.

Lincoln, Dodge County.—No; never did.—[Silas Garber.

Omaha, Douglas County.—I have never heard of a single instance. During a period of twelve years I have closely observed the doings of the Rocky Mountain locust, and have never known them to lay eggs two consecutive years in the same locality, and very rarely every other year.—[Ex-Gov. Alv. Saunders.

Patron, Butler County.—Never knew the eggs to be laid in the same ground for more than one year.—[J. Taunahill.

Plattsmouth, Cass County.—Yes; but hatched and matured only one season to do any damage.—[D. H. Wheeler.

Pleasant Hill, Saline County.—They have never laid eggs in the same ground in this portion of Nebraska for two consecutive years. Eggs were laid in 1874, none in 1875, vast quantities in 1876, and none in 1877.—[E. S. Abbott.

Salem, Richardson County.—No; I have never known the eggs of this locust to be *thickly* laid in the same ground for two consecutive years.—[B. F. Miles.

Springfield, Valley County.—No.

Steele City, Jefferson County.—Never; and I have known them here for ten years.—[D. T. Gantt.

TEXAS.

Austin, Travis County.—No. I have not, to any great extent, in this locality. The grasshoppers that came into this section in 1876 deposited their eggs in the same ground that the 'hoppers that came in 1874 had chosen. The only difference was that the eggs laid in 1876 were much more numerous.—[V. O. King.

Bastrop, Bastrop County.—I have not.—[James Moore.

Black Jack Spring, Fayette County.—No.—[J. C. Melcher.

Calvert, Robertson County.—In the years 1867 and 1868 the locusts visited this region and deposited their eggs, but not so thickly the last named year as the first.—[T. J. Moulton, jr.

Dallas, Dallas County.—I have not. No. No.—[J. Boll.

Denison, Grayson County.—Not thickly, but they laid eggs in 1875 and 1876. Never. I have not.—[T. V. Munson.

Headsville, Robinson County.—Never, as to my own experience, but I have heard old Texans say the Brazos country was visited two consecutive seasons, and eggs were deposited each. The second visitation, however, was feeble.

Helotes, Bexar County.—For three consecutive years past there have been laid eggs of the Rocky Mountain locust in the same locality and in the same ground; each time in very great numbers, yet in 1875 and 1876 they were more so than in 1874. This year we will have none, as before stated; no eggs are laid.—[H. Brous.

Houston, Harris County.—I have not heard of any, and none within my personal knowledge sufficient in numbers as to become destructive.—[A. B. Small.

Plana, Collin County.—No.—[H. C. Overacker.

APPENDIX XXIV.

MISCELLANEOUS DATA.

[Answers to questions 23–31 in Mr. Thomas's special circular, as follows: 23. State all you may know in reference to eggs hatching in the fall. 24. What plants, cultivated or wild, appear to be preferred by the young, and what by the full-grown insects? 25. What plants, cultivated or wild, appear to be least relished? 26. State to what extent the invading swarms have been observed to injure the native grasses, and to what extent the young have been observed to injure them. 27. What animals, such as quadrupeds, birds, and reptiles, have been observed feeding upon the young or full-grown insects or their eggs? 28. State what measures for destroying the eggs have been tried, and how far they have proved effectual. 29. State the ratio of prairie to timber in your section. 30. State all you know in reference to the habits of the young or grown insects during the night; where they remain; whether they ever march, continue to fly, eat, &c. 31. At what rate do swarms move during flight?]

MINNESOTA.

Norseland, Nicollet County.—26. Invading swarms have not injured the native grasses, but the young injure it greatly; from one-third to one-fourth is devoured by them. 27. Have observed none but tame chickens feeding on insects and eggs. 28. No measures for destroying the eggs have been tried in this section. 29. County consists of one-fourth timber and three-fourths prairie. Township all prairie, with only one-fourth mile to timber on the east, from two to three miles on the south, and a small grove just north of it. 30. At night both the young and grown insects sit still. If they are near any fence, growths, or anything elevated from the ground, they will crawl upon it. If they are on bare ground, they will go in clusters to remain overnight. 31. Depends upon the force of the wind; probably 10 to 15 miles per hour.—[Webster.

Dewald, Nobles County.—23. Do not hatch here in the fall to any great extent. 24 and 25. Pease and horse-radish are the only cultivated plants I am acquainted with that they won't eat, and among the wild the cockleburr, purslane, and helianthus seem to be exempt. When they can, they eat oats, flax, corn, wheat, and potatoes in this order. 29. No timber in this part of the State, excepting young plantations two to four years old. 30. Do not eat nor fly, roost on the fences, or get under clods of dirt, &c. 31. Rate of speed depends on the force of the wind.—[Bates.

NEBRASKA.

Farmers Valley, Hamilton County.—23. In the fall of 1874, the county was surprised to see numbers of small 'hoppers. 24. Wild buckwheat, onions, cabbage, carrots, beans, asparagus, parsnips, &c.; 1874, corn nearest maturity; 1876, earliest corn; their taste seems to differ with the times. 25. Pease. 26. Never been any injury done here. 27. Birds, snakes, frogs, toads eat insects; birds eat the eggs. 28. Harrowing. 29. Twenty-nine-thirtieths prairie, one-thirtieth timber. 30. At night and in rainy weather they go to high grass or stalks for shelter. I had a field of corn in 1874 that was standing and not seriously damaged when night commenced. The next morning it was only corn-stalks, leaves and ears having been eaten. [J. Vosburgh.] 23. A very few hatched in Fall of 1876. 24. Corn, timothy, clover, onions, potatoes, beans, turnips, petunias, foliage of fruit trees, willows, poplars. 25. Chufa, tomato, phlox, pansy, Madeira vine. 27. *Harpalus Pennsylvanicus* and a dipterous larva; red bug destroying eggs. 29. No timber except narrow belts along streams.—[G. M. Dodge.

Plattsmouth, Cass County.—24. Cabbage, turnips, and wheat invariably; others vary. My neighbor on an adjoining lot had his lettuce and pease entirely destroyed, while his other plants are untouched. In mine nearly all are gone but lettuce and pease, which are unharmed. 27. Hogs and birds. 28. About four-fifths prairie in Cass County. 30. The young cluster under leaves, clods, roots, &c., not at night, but in rain and cold weather; do not eat under such circumstances. The grown remain perched on trees, bushes, &c. When on the wing I am much inclined to think they fly all night. 31. Movements regulated by the wind.—[Child.

Sunlight, Cass County.—23. Never known any to hatch. 24. Radishes, cabbage, onions, tansy, rhubarb, wild and tame buckwheat. 25. Pease, tomatoes, sweet and

Irish potatoes, and vines. 26. No damage yet. 27. Hogs, squirrels, prairie, gray, and striped chickens, birds. 28. Fall plowing. 29. 98 to 100. 30. Grown ones fly up to roost; young crawl up on stubble, weeds, &c.—[Babbitt.

Steele City, Jefferson County.—26. They have never injured the native grasses. 27. Wolves and skunks eat many 'hoppers. 28. Dragging and plowing. 29. The only timber is along the streams. 30. They rest during the night on bushes, corn-stalks, &c. 31. According to the velocity of the wind, 15 or 20 miles per hour.—[Gantt.

Falls City, Richardson County.—23. Do not hatch in the fall. 25. Green pease, sorghum, corn. 26. Clover is killed almost the first thing. Timothy stands a poor chance. 28. Deep plowing and harrowing. 29. Nearly one-fourth is timber.—[Hutchings.

Arago, Richardson County.—23. Never hatched in the Fall here. 24. Cabbage, tobacco, turnips. 25. Sugar-cane, sorghum. 26. The grass has not been injured. 27. Hogs and domestic fowls. 28. Plowing. 29. Ninety per cent. 30. They crawl up to the top of fences, bushes, weeds, and grain. 31. Five or six miles.—[Gerdes.

Grand Island, Hall County.—25. Apple trees, crab-apple trees, pease, cherry, plum, peach, were all more or less damaged; plum and crab-apple least. The coffee-bean tree, ash-leaf maple or box-elder, soft maple, honey-locust, elm, black willow, Rocky Mountain evergreens, red and white cedars, were injured but little. The black locust, white or grey willow, black and white walnut, European larch, American larch, Scotch pine, white pine, Norway spruce, were injured a great deal more. The grape-vines, wild and cultivated, were let alone until the apple trees were all stripped. 26. Native grasses injured very little. 27. Wild and tame pigeons, on eggs and young; domestic chickens, turkeys, prairie chickens, grouse, and quails in any stage of their development. Blackbirds feed on the young. 28. Deep plowing satisfactory. 30. Toward evening the young 'hoppers climb bushes, poles, sticks, small trees; and on wet and cold days they seek shelter under anything that will shield them.—[Stolley.

Genoa, Platte County.—25. Sorghum and broom-corn. 29. Timber 1 per cent.—[Truman.

Niobrara, Knox County.—25. Pease, tomatoes, beans. 26. No injury to grass, but they are to young trees. 29. One-fifteenth timber. 24. By the young, tender blades of wheat. By the old corn, and ripe kernels of oats.—[Hulleban.

Hooper, Dodge County.—25. Broom-corn, sugar-cane. 26. Never injure them worth mentioning. 28. Scarcely any. 29. From 5 to 10 per cent. 30. Never move at night unless disturbed. 31. From 5 to 20 miles per hour.—[Eisley.

Pleasant Hill, Saline County.—23. No evidence of Fall hatching. 24. Everything but sorghum and pumpkin vines. They have a particular regard for tobacco and onions. 26. Have never injured the native grasses. 27. Snakes. 29. Probably not one-fiftieth timber. 30. Young insects quiet at night. The old ones collect on trees and shrubs, sometimes in sufficient numbers to bend the trees. 31. Owing to force of wind, 4 to 30 miles per hour.—[Abbott.

Chapman, Merrick County.—23. Know of no eggs hatching in the Fall. 24. Onions, cabbage, corn, sweet potatoes, potatoes, grains in the order mentioned. 25. Sorghum, broom-corn, peach trees, box-elder. 27. Prairie chicken, plover, blackbird, lark. 26. They do not injure native grasses. 29. But little or no timber. 30. They feed mostly on cloudy days, in the evenings, and warm nights. They crawl up on all kinds of vegetation of an evening, and stay until the hot sun of the next day; then they seek the shade. 21. Always travel with the wind.—[Cox.

Burr Oak, Otoe County.—29. One acre of timber to one hundred of prairie.—Davidson.

Fremont, Dodge County.—23. Eggs have not hatched here in fall. 26. Never have known them to eat native grass except when hatched on it, and when they could get nothing else. Will eat anything rather than "pass in their checks." 28. Deep plowing successful. 29. Proportion of timber very small. 30. Do not fly, but sometimes eat at night. If flying, they will light before sunset. 31. They move with the wind, so their flight depends on that.—[Blanchard.

Ponca, Dixon County.—24. Onions, cabbage, tobacco. 25. Tomatoes, beets, pease. 26. Never knew native grass to be injured by old or young ones. 29. Prairie 20 to 1 of timber. 30. The young do not eat at night, but crouch down under some grass or bush or around a lump of dirt. The old ones eat all night as well as all day, to my certain knowledge.—[James Rockwill.

Friend, Saline County.—23. No eggs are known to have hatched in the fall except by artificial means. 24. Young prefer onions, strawberries, wheat, oats, and barley. Old onions. 25. Pease and sweet potatoes by both. 26. Native grasses have not been injured visibly. 29. Prairie to timber, ninety-nine-hundredths prairie. 30. The young and growing remain under straw, earth, hay, &c. 31. From 4 to 6 miles per hour, according to force of wind.—[Whitcombe.

IOWA.

Alta, Buena Vista County.—23. A very few, which were deposited early in the season by straggling 'hoppers from swarms in a warmer climate, hatched out in the Fall; those deposited by invading swarms did not until spring. 24. Tobacco, corn, onions,

and cabbage. 25. Sugar-cane, broom-corn, flax, pease. 26. Not at all. 27. Hogs and all birds, domestic and wild. 28. Deep plowing and harrowing in the Fall, and harrowing in February. 30. Neither fly nor eat, but sit still where they are when night comes. 31. Rate varies with the force of the wind.—[Thompson.] 23. Sandy knolls with southeast slopes produced a few young last fall. 29. Exclusively prairie. 30. The very young get under clods or anything to keep warm; the older prefer to ascend anything to roost. Do not march or fly, but destroy where they roost. 31. Owing to force of wind. Last Fall when they went from here they went at the rate of from 40 to 60 miles per hour.—[Crowell.

Lake City, Calhoun County.—22. I do not think they ever hatch in the Fall. 25. Onions, tobacco, barley, wheat, oats, corn, full-grown same as young. 25. Prairie-grass, pease, sugar-cane, and most of the weeds. 26. Very little in either case. 27. Turkeys, chickens; native wild birds feed on both young and old; the red parasite destroys many. 28. Plowing deep and harrowing late in the Fall and early in the spring. 29. About 1 to 40. 30. They will gather on trees, fences, weeds, cornstalks, &c., to roost. Do not eat nor travel at night. 31. They go with the wind.—[Jack.

Sioux City, Woodbury County.—26. The young 'hoppers appear to eat the young, tender wild grass about as much as anything else. 31. The young 'hoppers appear to lie dormant at night, congregated on fences, straw, stubble, young trees, &c.; the old ones seem to work the same.—[Skinner.

DAKOTA.

Sioux Falls, Minnehaha County.—23. None hatched last fall, it being very wet. 24. Corn, wheat, oats, turnips, beans, onions, foliage of fruit-trees, currants, &c. 25. Sugar-cane, pease, tomatoes, and squashes. 26. Not any. 27. Blackbirds and wheat-birds appear to pick up eggs. 29. All prairie.—[Clark.

Saybrook, Clay County.—23. None. 24. Corn, cabbage, and onions. 25. Strawberries and tomatoes. 26. Never injure it the least. 27. The little red bug. 29. Not more than 1 per cent. 30. Appear to sit still behind the sheltery side of anything to keep warm; sit still; don't eat.—[Hall.

Madison, Lake County.—25. Sorghum and pease; especially sorghum. 26. Very little damage done. 27. Nearly all domestic and wild birds. 31. Depends entirely upon velocity of the wind.—[Law.

Spring Valley, Turner County.—23. None hatched here. 24. Wheat, corn. 25. Tumble-weed. 26. None at all. 27. Blackbirds and domestic fowls. 28. None. 29. No timber here.—[Andrews.

Olivet, Hutchinson County.—29. No timber. 30. They surely fly at night during their passage, as they are seen every fair day during summer on the wing, but do not light at night. 31. They always go with the wind and at the rate of the wind.—[Jones.

Sioux Falls, Minnehaha County.—27. Hogs eat the full-grown insects. 30. Young 'hoppers will go five or six rods to get into straw or high grass for the night.—[Everett.

Willowtown, Armstrong County.—23. Few only, caused by late setting in of winter. 24. Grain, corn, pease, and nearly all other cereal. 25. Rye, barley, and grass. 26. None. 27. Nearly all feathered tribes. 28. None. 29. 99 to 100; *i. e.*, 99 prairie, 1 timber. 30. Think they lie still at night. 31. According to velocity of wind.—[Taylor.

Wahpeton, Richland County.—24. Garden truck, oats, barley, wheat, potatoes, buckwheat. Coats, or other clothing, saddles, leather whips, &c., left on the ground a few hours would be ruined. 26. They do not seem to have made much impression. 27. Domestic fowls. I have observed my tame crane gathering them in. 28. Plowing in fall and early spring. 29. Almost entire prairie; small clumps of timber. 30. Neither fly, march, nor eat at night. Congregate in piles two or more deep, or on small shrubs and weeds. 31. About the same velocity as the wind.—[Smith.

Walhalla, Pembina County.—23. They do not hatch in the Fall. 24. It is said they begin to eat in the places where they alight, and that they don't care whether they are cultivated or wild. They prefer plants which are young and tender, especially onions and lettuce. When they came to Manitoba in 1868 they ate things which were not eatable, such as the paint off the doors and cupboards, the bark off the trees and logs; they ate holes in the carpets and articles of clothing. An acquaintance of mine gave a pill to one, and it ate it. They were lying so thick around the fort (Garry) that those residing in it had to hire some men to haul the dead ones away. * * * They had died simply for want of food; they were so famished that they devoured each other. * * * The prairie and woods were quite close by. Why did they not go there? 25. They do not relish pease. 27. Prairie chickens, domestic fowls. 28. No measures have been taken. 29. About one-eighth timber to prairie. 30. Locusts neither fly, march, nor eat at night. 31. Swarms moved at the rate of three miles per hour.—[Ernestine Mager.

APPENDIX XXV.

REPORTS FROM DAKOTA, MONTANA, UTAH, AND NEW MEXICO.

DAKOTA.

[After giving direction of flights through the summer, as furnished by the Signal Service.] I have not seen the deposits of their ova in either this or previous years, though I have been informed by General Stanley that prior to the year 1870 they hatched in great numbers in this vicinity.

At Swan Lake, about forty miles northwest of Fort Sully, grasshoppers were hatched the present season and attacked a field of corn, which had reached the height of about four or six inches, and devoured every spear of it, eating it quite even with the ground; but it sprang up again, and the planter sustained no loss save the retarding of his crop.

At Yankton the 'hoppers appeared a few days earlier than at this post, and the corn being in "silk and tassel," they destroyed the foliage, leaving the bare stalk to blight and wither in the sunlight. At Fort Thompson they destroyed the crops completely; so also at Brulé agency. They have done comparatively no damage in the vicinity of Sully, neither at the adjacent settlements at Medicine Creek, Peoria Bottom, or the Little Bend of the Missouri. I can account for this only on the fact that the soil only on the river-bottom is tilled at these settlements, while the 'hoppers have a preference for the upland prairie, and seem to be satisfied with the rich pasture afforded by the buffalo and grama grass, rarely attacking the foliage of the cottonwood and other deciduous trees, though these in the vicinity of Yankton fail to escape their depredations.—[Letter from A. J. Comfort, acting assistant surgeon, United States Army, Fort Sully, September 11, 1876.

In the summer of 1875 the grasshoppers hatched in the vicinity of this post, took wing about June, and left in the beginning of July.—[Letter from L. C. Hunt, lieutenant-colonel Twentieth Infantry, Fort Totten, December 28, 1876.

Vid., also, Capt. William Ludlow, Report of a Reconnaissance of the Black Hills of Dakota in the summer of 1874:

Page 9.—Grasshoppers at Fort Lincoln in June.

Page 10.—July 10, immense numbers on North Fork of Grand River.

Page 14.—July 30, grasshoppers appeared, eight or nine miles from Harney's Peak.

Page 15.—August 7, grasshoppers in creek valleys of the Hills.

Of the grasshopper invasion of Minnesota in 1856 or 1857, I know almost nothing. I was then living near the Yellow Medicine in Minnesota. We had in those years an *abundance* of grasshoppers, but no *army*, and no considerable damage was done.

In the month of June, 1873, a comparatively small number of grasshoppers came from the westward and alighted near this place. They did some damage, but it was not extensive. They left in a few days but it was found in the spring of 1874 that they had deposited their eggs, from which came an innumerable multitude. They destroyed all the gardens and wheat-fields in a circle of five miles about the agency. * * * This year (1875) they have passed over this part of the country, going in a southeasterly direction. (I tried to get Mr. Riggs to fix the date, but he could not recall it.) One day they lit down in considerable numbers, and there is reason to fear they deposited their eggs. [They did, and a few were hatched there in 1876.]—[Letter of Rev. S. R. Riggs, Sisseton agency, Dakota, September 9, 1875.

1875.—The grasshoppers in 1875 came from the north on or about the 10th of July. They alighted here, but seemed to be sluggish and did no damage, and after remaining three days arose and flew southeast.—[Hector Bruce, Grand Forks, Dakota.

1875.—Grasshoppers hatched in this county in the year 1875, and the country north and northwest of this place for a long distance was alive with young 'hoppers. Those hatched here took flight about the 10th of July, taking a southwesterly direction. Other swarms from the northwest passed over this place high up, bearing a south course. I cannot recall the dates, but they were from about the 20th of July till late in August.—[Extract from letter of Merrick Moore, Jamestown, Stutsman County, April 16, 1877.

Yours of the 7th instant duly received. In reply I would state that I believe locusts hatched to a very large extent in the valley of the James River in 1876, as I know they

did on the Coteau, and just off on the low lands for ten miles to the west of this post, which was as far as I visited in that direction last year.

During 1877 locusts hatched in this vicinity last spring in considerable numbers, but did but little destruction in this vicinity.—[Extract from letter of Dr. Charles E. McChesney, Fort Sisseton, Dakota, September 13, 1877.

While I was on the Missouri River, near Fort Sully, there was an alighting of 'hoppers about the 10th of this month. They came on the west wind. For several days they were flying, but not in great numbers. They came down and seemed to increase from day to day for several days, until they were very abundant. They tried the corn in the Missouri field, but it was too hard for them to damage much. The potato tops were still green; they ate them pretty well off. They worked on melons and beets considerable. If it had been a month earlier they would have greatly damaged the field—perhaps destroyed it. As it was they did but little hurt. On the way over, as we came eastward, we found them on the Missouri Coteau, somewhat annoying in traveling, but in no large numbers anywhere.—[Extract from letter of Rev. S. A. Riggs, Sisseton agency, September 28, 1877.

Fort Rice, Dakota, September 12, 1877.—I am not aware of any locusts having hatched here in the spring, and no swarms have been observed passing over this locality or neigborhood this year. An occasional grasshopper was seen here during the summer, but never in swarms, and the crops have not been injured by insects of any kind.—[Blair D. Taylor, assistant surgeon, United States Army, post surgeon.

Fort Totten, Dakota, September 16, 1877.—1st. No grasshoppers were hatched in this vicinity last spring. 2d. There is no record of the time at which swarms were seen passing this summer. It was some time in July, and they were not noticed more than three or four times. None alighting and no damage whatever was occasioned. Their general movement seemed to be to the southeast, but varied with the wind, coming back from the same direction. 3d. No eggs have been left in this immediate vicinity.—[A. A. Harbach, captain Twentieth Infantry, commanding.

Lower Brulé agency, September 16, 1877.—In relation to the incubation and movements of grasshoppers in this region, I have to say that the hospital records at this post indicate that, so far as can be ascertained, no grasshoppers have hatched or passed or alighted during the present year within seventy-five miles of this station—[L. D. DeRussy, Captain First Infantry, commanding the station.

Fort Sully, Dakota, October 6, 1877.—1. No locusts were discovered as having hatched in this vicinity. 2. Swarms were first seen flying north on the 22d of June, and continued to fly in a northerly direction in immense clouds until about the 10th of July, when they stopped flying past here. None of the swarms alighted. It has been observed by me that when the grasshoppers are on the wing, if the wind is fair they do not alight; but should the wind suddenly change and blow a little fresh, they immediately alight and remain until the wind becomes favorable again, when they with wonderful unanimity take wing and fly off on their intended course. I observed this peculiarity, particularly in June, 1875, when they alighted here, remaining only three days, but destroying all small vegetables during their short stay. 3. Grasshoppers have been quite numerous along the river-bottom in this vicinity during the past month, but I am of the opinion that they have been driven in here by prairie fires that have burned the country for many miles around this post. I observe them copulating quite extensively up to the present. We had quite a severe frost the night of the 2d and 3d instant, making ice a half inch thick, since which time some of them have disappeared. I think they have sought shelter in the long grass and weeds. They seemed very ravenous, eating up everything green, and even the small potatoes left on the ground ungathered. I have just this day, for the first time, discovered some few of them depositing their eggs, but I do not think any danger may be apprehended next summer from the small number in this vicinity—[Leslie Smith, captain First Infantry, commanding post.

1877.

Milltown, Armstrong County.—Very few hatched in this county this year; some died off, cause unknown.

Forestburg, Bramble County.—No 'hoppers nor eggs at present, May 18.

Scotland, Hutchinson County.—No eggs within 18 miles of here.

Gary, Deuel County.—New settlers from Yankton to Lake Kampeska did not see a single grasshopper. I was out 18 miles northwest of here yesterday and saw none; none in the county.

Grand Forks, Grand Forks County.—No grasshoppers in this section this year. A few passed over at different times during the month of July, but none lit. No eggs here.

So far as I have been enabled to learn by inquiry, which has been confined, however, to the southeastern part of Dakota Territory, the series of invasions by locusts included in the period 1872–1877 are all that can be reported. Occasionally I have met Indians who vaguely say, "Me see plenty 'hopper five, six, eight year ago." I have not been able to learn anything about such early visitations. A late resident of Brookings County, now living in Massachusetts, reported to me that during the summer of 1870

a great swarm of the locusts made a descent on the prairies in one part of that county where there were no cultivated fields, and that he also observed birds of a new species to his observation, that seemed to prey on the 'hoppers. The birds were in great numbers, and the swarm of 'hoppers soon disappeared. Such is the substance of his report. It is as complete as his observations enabled him to make. I have met with some apparent reluctance to give information, because many people object to having the report go out that locusts cause us any trouble.

My own first observation of the locusts was in the month of May, 1873, in Union County, in the southeast corner of this Territory. While crossing a broad flat prairie, between Richland and Elk Point, where the land was at the time covered with water from six to ten inches deep, the air suddenly seemed clouded and filled as with snowflakes, and the locusts loaded every blade of grass that reached above the water, and continued flying in great numbers overhead all day. It was a new phenomenon to me and I was much astonished. Great numbers perished in the water. Where the lands were cultivated and the young grain was just getting a start, the work of destruction was very apparent. This was early in the season, and the locusts were full fledged. Where they came from I did not learn. I had not at that time any thought of investigating their habits.

The swarms of locusts during that year, 1873, did very great damage over a considerable portion of Southeastern Dakota as far northward as in Minnehaha County, where I had opportunity to observe their ravages. In October of that year I rode across the country from Canton, in Lincoln County, to Vermillion, in Clay County, and observed a large number of fields that had not been harvested, because the locusts had destroyed the grain.

The next year, 1874, was the year of most marked devastation. During the summer from somewhere about the first part of June, the swarms of locusts were observed moving with the wind, and occasionally some would settle on the prairies, but not so as to damage much, if any. In our part of the country, in Brookings County, I think no general alarm was felt. We had never suffered from them, and hardly realized that there was danger. The 17th day of July the locusts were observed as flying lower than usual, and when soon after noon the wind, which had been blowing from the northwest, ceased, the locusts came down like a thick snow-storm, and covered ground, woods, fields, and everything, loading down corn and other grain until it would droop to the ground, unable to support the weight. Many means were tried, fire and smoke, and stirring and whipping with brush, to try to drive them off, but to no purpose. The attempt to cover plants in the garden proved futile, for the 'hoppers would eat sheets, quilts, blankets, and carpets. By constant labor with brush my wife and I fought for a little patch of potatoes in our garden, and prevented their total destruction. This visitation continued until the morning of the 19th, when a northwest wind sprang up and the locusts left. On reviewing the situation it was found that some portions of some fields might partially recover and so a little be saved. It was observed that the devastation was mostly on the north and west sides of fields. Also that broad fields had lost much less in proportion than long narrow fields. The red parasites on the wings were observed, but not on a large proportion of those examined.

This visitation gave our settlement almost a panic. The swarms continued to fly overhead, and now we were constantly in expectation of another visit from them. The time passed on, however, so that we began to entertain a hope that we might be permitted to harvest what had been left to us, until, on the last day of July, the locusts again descended on us in forces exceeding even the former visit, and after two days of their work the settlement was in consternation at the loss of every vestige of grain and produce of any kind. Only one little garden spot, for which my wife and myself struggled through day and night to save, escaped total destruction. We raised our potatoes, cabbages, and ruta-bagas that year, and they were, so far as I know, the only crops saved by fighting the 'hoppers.

I have here to report a curious phenomenon. My farm lies along the southeast shore of a little lake, that is about two and one-half miles long, and averages about three-quarters of a mile wide. *A farm lying just across the lake from mine, distant only the width of the lake, was not injured at all by the locusts.* With that one exception, the devastation extended throughout the whole county, and through nearly all of the southeastern counties of the Territory. This gave occasion for the efforts that were made to procure relief for impoverished settlers that following winter. The poverty and the suffering were by no means mythical, as some have seemed to believe.

I have no memoranda of flights and movements of locusts for that year.

Early in the spring of 1875, on account of a failure of health resulting from undue exposure to weather and storms, I started on a tour in Minnesota, Iowa, and Wisconsin. Traveling through the southwestern part of Minnesota, I observed the effects of the work of the locusts in deserted farms.

On turning again toward home I left Saint Paul July 23. I passed Redwood Falls, Minn., on the 25th, and found that I was in a region in which grasshopper devastation was going on. They seemed to be moving westward. I reached Lake Benton in Lin-

coln County, Minnesota, on the evening of the 26th; the locusts were just getting into work there.

The next day I reached home, distant 30 miles west of Lake Benton. I observed the locusts at work on the east side of the Big Sioux River. My own part of the settlement on the west of the river was yet free from locusts. On the 28th, however, all seemed to be lost. The immense swarms, of which I had just kept in advance on the route from Redwood Falls, came rolling over the country. The word "rolling" seems to express the appearance of the movement. The movement of the mass seemed like a great roller moving over the ground. They would drop and rise, make a curved flight and drop again. They did not begin ravenously as they did the previous year. Some would eat, and great numbers continued their motion. It would seem almost as though they would tell us they had come for a long visit and proposed to take their time. The visit lasted seven days. It appeared as though the swarm was making a kind of progress, during the first three days, toward the west, after which they seemed to desire to go south. The movement was constant during the day, but at night ceased. In the morning they seemed to do most of their eating. A shower of rain induced them to settle for a time, and when the rain ceased their ravages were fearful. The return of sunshine set them in motion again.

On the third day they were observed to be copulating. The general apparent progress of the swarm was kept up, however, and while the ground would be covered with the locusts the air would be full of those moving on.

The fifth day they were observed to be depositing eggs. This continued during the remaining period of the visit, and on the 4th day of August the swarm took final leave of us. The destruction had been very great, but not so as to leave us without resources. Our settlement saved grain and produce enough so that we were able to live. The phenomenon of the year before was repeated on the farm just across the lake from mine. No harm was done there and no eggs were laid.

When we had a chance to look around to see what had been done in other parts of the Territory, it was found that partial destruction had extended down the valley of the Big Sioux River, but nowhere except in the south part of Brookings County had the eggs been deposited. The region of the ovipositing extended eastward into Minnesota.

We were not troubled any more by locusts so far as I know in the Territory during that year. We were, of course, somewhat anxious about the coming of the next spring. The question whether enough young locusts would hatch to damage materially was full of melancholy interest in our settlement. Eggs were dug up and examined in the Fall to see what their condition would promise. The young locust was found to be fully formed and filling the shell. Question, *will they winter-kill?* Some thought yes, some no, but no one knew anything about it.

Spring came and the ground was anxiously watched. Every farmer put forth all his ability in the way of preparation for crops. The 11th of May, while I was marking a corn-field for a neighbor, he called me to look at the young 'hoppers coming from the ground on a southern slope near his house. They came up from the soil; color, yellow, rather flat, about three-sixteenths of an inch long; color soon changed to dark brown. The next day the hatching progressed rapidly. During about seven days, as near as I could observe, there were accessions to numbers by hatching. They came to the surface with an appetite, and began immediately to gratify it. Their work seemed wonderful for such small creatures. On fields that had not been plowed since the depositing of the eggs, the young locusts swarmed in great numbers all over. On fields that had been plowed, either in Fall or spring before the hatching, they began depredations on the edges, and in the case of broad fields there was not total destruction.

The advances were made from the north and the west sides of fields. The young locusts, the larvæ, seemed especially fond of strong garden vegetables, such as onions, peppers, turnips, &c. Potatoes were eaten also. They did not seem to relish tomatoes, nor squash, nor cucumber-vines. They would eat cabbage-plants with avidity. A patch of field-peas (called Canada field-peas) they would pass over and not eat. Garden-peas of earlier and sweeter kinds they would eat to some extent. Strawberry-plants were eaten, and also rhubarb (pie-plant). The general grain crops they would make steady work on. They do not like Hungarian.

I had a field of oats on the west side of which the larvæ had begun their work, and I wanted to plant a row of trees on the edge of the field, so I plowed about four furrows in width, thus stirring up fresh soil and turning under large numbers of the 'hoppers. The destruction ceased entirely along that side of the field. They made some advance from the north side of the field, but I saved finally more than half an average crop from the whole field.

I have no doubt of the efficacy of Fall or early spring plowing, to the depth of five inches, in causing the destruction of very nearly all the eggs.

The period from hatching to fledging was forty-five days. From June 25 to July 3 the full-fledged locusts were observed to rise in occasional swarms and move off with the wind.

That part of the Territory of which I am treating, the southeastern, up to the middle of July, gave glorious promise of abundant harvests. In my travels I observed fields such as I had never seen before for their richness. All kinds of grain seemed to promise the heaviest possible yield. We in our settlement, having suffered considerable loss from the young 'hoppers, yet hoped, for such abundance near us that we could get supplies without distress. During the last half of July immense swarms of locusts were observed, and at the last (I have not the date, but about the last of July) the enemy swooped down on those magnificent fields, and they melted away like frost before the morning sun. In the extreme south part of the Territory some wheat was saved by early ripening. Wherever the grain had so far matured as to make it seem possible to save any, reapers and harvesters were run day and night. The net result was an average of about one-half a crop saved, but of immature grain, and therefore of inferior quality. Grain in the bins would be a strange-looking mixture of mutilated and dissected 'hoppers.

In this connection may be put the report I made to you of the geographical deposit of eggs during that year. My reports will then cover all that I am able to give during this year, except to answer your question, as to how far the hatching region proved to coincide with the reported egg region.

I have not been able to get as full information as I desired on this point. If you can refer to the map I sent you, you will observe that the line commences in Moody County, and making southwesterly, strikes the Missouri River not far from Springfield. The hatching in general would on its northwestern boundary be marked by the same line. Moody, Minnehaha, Turner, Hutchinson, Yankton, and I think also Bonhomme Counties, had some experience with young locusts last spring. Lincoln and Clay and Union I am not able to report. Methods were invented, and "'hopper dezers" were used quite extensively, and with good results. The 'hoppers did hatch, but have not been able to do much in the way of damage. In fact, it seems almost as though the difficulty were solved by human ingenuity. Persistent attacks on young locusts as were made last spring, with the united forces of all interested, ought to be a safeguard for the future.

The general conduct of the locusts during the past summer has been curious in my view. In this part of the Territory only here and there an occasional field has suffered. The farm across the lake from mine, which has heretofore escaped, had a visit, with only slight loss, however, this year. A field of oats about one and one-half miles northwest of my place was so far destroyed as to make it a total loss, for it would not pay to harvest. In a settlement in the northern part of Brookings County, in one field and one garden considerable damage was done. In Minnehaha County the same conduct was observed. The cases of damage were sporadic, in some places a field totaly lost, and some only slightly damaged.—[G. S. Coddington, Dell Rapids, Minnehaha County, Dakota, December 10, 1877.

SIR: In compliance with your request, I send a report of my observations during the present season, made at this place, upon the *Caloptenus spretus*, or Rocky Mountain locust.

There were no eggs deposited here in 1876, consequently no young insects hatched here.

The first seen flying were, in small numbers, observed June 20, at about 11 a. m.; the wind, a moderate breeze, blowing from the southeast. Their course was with the wind to the northwest. On the following day they were seen in slightly increased numbers flying in the same direction and generally with the wind. A few alighted, but on the 22d they had all left, having done no damage to crops; in fact they did not seem inclined to eat anything.

On the 21st July they were again seen quite high, and flying with the wind toward the northwest; and, occasionally, one alighting. On the following day they were seen in greater numbers, their course, as well as the direction of the wind, being from southeast to northwest. They did not seem to alight on the night between the 21st and 22d, but on the morning of the 23d they were found on the ground in considerable numbers.

24th.—Flying northwest and high.

25th.—The same, but more numerous.

26th, 27th, and 28th.—Flying in the same direction, but many alighting, especially on the 28th, when the wind was blowing from northwest toward southeast.

From this time to the 7th of August they were seen daily, and in about the same numbers, their general course being northwest, though occasionally they were seen flying east or southeast with the wind, and sometimes they were moving in different directions at different altitudes, when the currents of wind were moving in that manner. From the 7th to the 11th they kept decreasing, until, on the latter date, they had all disappeared, none to be seen either flying or on the ground.

When on the ground they ate nothing, and not more than 1 per cent. paired, and no eggs were deposited. Red parasites were found upon many of those caught in the latter part of July and first week in August.

I have sent specimens of *Caloptenus*, preserved in alcohol in tin can, to headquarters Saint Louis, as requested.—[Geo. W. Sweet, Bismarck, Dak., September 18, 1877.

I have just (to-day, January 14, 1878) been able to get hold of the Yankton *Press* for 1871–'72. For 1871 you will see there is very little. The item about 'hoppers about Berthold indicates that they probably appeared there. The contradiction in the editorial is probably a contradiction of the alleged destruction, not of the fact of appearance. For 1872, it seems there was a migration southward across the southeastern counties. It is stated in one of the items that it did not reach as far east as Sioux Falls, and in the letters that I have received from the East Dakota counties north of Sioux Falls nothing has ever been said of their appearance there, nor in any of the Southwestern Minnesota counties. In fact, all those counties, both in Minnesota and Dakota, were hardly settled then. The damage seems to have been trifling; at least I should judge so from all that the press has to say about the crops that fall.—[A. Whitman.

The following item we found in the Chicago *Tribune* of the 26th. From passengers by steamboats that passed Berthold at a later date than this informant purports to have written, we learned that crops have not been injured, and the probability is there is not the least foundation for the report: "The destructive force of a grasshopper visitation is indicated in a note from a settler in Dakota, who writes from Fort Berthold, July 26: 'Everything was growing finely on the farm until this morning, when, at about 11 o'clock, the grasshoppers arrived, and have very nearly cleaned us out. Our gardens are entirely ruined. From the oats we may save enough straw for the horses, but everything in the gardens and in the fields of the Indians is totally consumed. The whole work of the season was destroyed in less than eight hours over a country of three hundred acres.'"—[*Yankton Press*, August 30, 1871.

In a letter from Liberty, Dak., a storm is reported. Some oat-fields out of range of the storm are badly damaged by the native grasshopper (large yellow). They eat off the kernels until the ground is covered. During several days of the past week the air has been filled with those pests, which but a few years since were such a terror to the farmer of the Northwest. They appeared to be making their way due south, and will probably bring up somewhere in our sister State of Nebraska. A few of them, weary of their pilgrimage, dropped down upon our people in certain localities; but from all we can learn, Dakota has little to fear from these unwelcome visitors the present season. If they must visit Dakota, a flying visit, like the present one, will suit our people best.—[*Yankton Press*, August 7, 1872.

H. Beardshear, living in Dixon County, Nebraska, says that the grasshoppers appeared near Ponca on Friday, and were committing fearful ravages. He noticed fields of oats and corn perfectly black with them, they being so thick as to bend the oat-stalks to the ground. They seemed to be devastating a strip of country about sixteen miles in width, and appeared to be working in a westerly direction.—[*Sioux City Journal*, 1872.

The latest news from all parts of the Territory convey the happy intelligence that the grasshoppers have departed for parts unknown. The damage done by these unwelcome visitors has been but small, and it is sincerely to be hoped that this is an end of the big grasshopper scare. The grasshoppers gave Sioux Falls the cut direct—didn't even make that point a way-station.—[*Yankton Press*, August 14, 1872.

The grasshoppers have not all left Dakota; we have them here, though not so many of them as have visited some of the adjacent counties, and they have not done much injury to the corn so far.—[Letter from Hutchinson County, August 22, 1872.

From Union County, August 24, the news comes that the grasshoppers had injured crops but very little, and finer fields of wheat and oats than those which grace the farms of Union County are never seen except in imagination.—[*Yankton Press*, September 4, 1872.

MONTANA.

FORT PECK, MONT., *June* 30, 1877.

SIR: Your circular in regard to the Rocky Mountain locusts was received some days ago, and I have been hesitating about an answer, because I do not feel competent to communicate anything of scientific value. I am not a naturalist, and have never given the habits of the 'hoppers any consideration.

1. I recall arrivals at Standing Rock, Dak., in 1875, and at Fort Randall, Dak., in 1876, in the afternoon. In 1874, in Southwestern Minnesota, saw a wheat-field attacked and swept away in the forenoon, but did not inquire the time of the arrival of the pest in that vicinity. This was early in July, or before the middle of the month. *a*. Direction of wind not noted, or not remembered. *b*. Weather generally, if not invariably, warm and clear. *c*. Generally, if not invariably, with the wind. Height and density various. Sometimes invisible to the natural eye except when viewed nearly in the direction of the sun, when the volume seemed of great depth and density, and continued for many hours undiminished; also much nearer the surface of the earth, presenting, in the distance, the appearance of the smoke of immense prairie-fires, and

again skimming along the surface of the earth, rising and falling in countless myriads.

2. Do not recall the time of day of the departure of any swarms.

3. The locusts, numerous here at present, have been copulating for several days. They were hatched here before my arrival. Have never noticed the deposit of eggs.

4. Have generally noticed the appearance toward the end of May. Recall large crops at Grand River, on the Missouri, in 1874, and at Fargo, Red River, in 1876, while attending court there. They appear to attain full growth toward the end of June. Those now here were hardly grown when I arrived, twelve days ago.

5. Recall no material departure from the foregoing times.

6. No observations.

7. Observations confined to non-timbered bottom-lands and low prairies on this (Missouri) river, and the valley of the Red River of the North.

8. Bottoms dry and sandy, covered with grass, weeds, and wild roses; prairie, black loamy sod, covered with grass.

9. See answer to question 4.

10. Early in July. Observations mostly north of 45th parallel; from that to the 48th, north latitude; and they have generally left without attacking the gardens in the vicinity of their nativity.

11. Have seen great devastation in Minnesota early in July, 1874; also in Southwest Iowa and Southeast Dakota at the same time, while traveling in those parts. The damage in the same region of Dakota last July (1876) was considerable. In both instances the 'hoppers came from parts unknown to the west, southwest, and northwest. No agriculture near the posts on this river where I have been stationed except garden-patches. These gardens have occasionally been destroyed by 'hoppers, but more frequently by potato-bugs and gray beetles.

12. They generally spare nothing in fields or gardens where they light.

13. Knew one man to save his potatoes by covering them with straw during the passage of the locust. Have only slight newspaper knowledge of the various expedients that have been tried for the protection of crops to the east of us.

14. See answer to question 12.

15. No data.

16. None.

17. No effort at destruction. The only successful effort at protection is given in answer 13.

18. None.

19. Was not here in 1876. Was stationed at Fort Randall, Dak., which was visited, but the garden, about 30 acres, on bottom-land, surrounded on three sides by timber and the fourth by bluff, was not attacked. Visit in July.

20. Do not remember the dates of visitations at other posts in Dakota, but do not think that any occurred later than the end of July, or the early part of August.

21. Little chance for observation. Domestic fowls at the military posts feed on the insect with avidity.

Finally, I have noticed no difference in the insects seen at various times and places. The only parasite I have seen preying upon them is a small red bug. In 1875, if I remember events correctly, a season of ample rain-fall in Southeast Dakota, these parasites attacked the locusts in great numbers, and it was believed they were the means of forcing the pest to return west without doing any appreciable damage to the crops.

Very respectfully,

S. S. TURNER,
Acting Assistant Surgeon, United States Army.

To A. S. PACKARD, Jr., *Salem, Mass.*

DEER LODGE, MONT.—The locusts arrive all times of day, never at night, always coming with the wind; and if it becomes adverse or blows very hard, they light until it ceases or nearly so. The swarms depart usually as soon as the sun warms them up, at 8 or 9 a. m., the direction of wind at the time being usually north or northeast, the weather being clear and warm. They usually fly to the south or southwest, but in some instances to the southeast, rarely to the east; the flight in the latter direction local only. No eggs were deposited this year (1877), but they are usually deposited in dry soil, mostly in August. The eggs usually hatch in May. Large fields of grain are injured less than small ones by the young broods, for the reason that they usually mature and fly away before reaching the middle of the field. The young locusts usually travel to the south and southwest, the course in which they afterward fly, but if any obstacles are met with, will diverge and sometimes return on their trail. Blackbirds and snowbirds are particularly useful in destroying them.

In 1876, swarms hatched in several places in this valley, and did considerable local damage before taking flight. A heavy swarm from the northeast passed over in July, going southwest, being several days in passing. The crops were too far advanced for them to do much injury.

The locust years and directions from which the swarms came at Deer Lodge were, 1866, from north; 1869, from northeast; 1872, from northeast; 1874, 1875, 1876, usually from north and northeast. They mostly departed in a southerly course.

I came to Montana in 1857, but saw or heard of no grasshoppers until 1866, except on the Yellowstone, where my brother, James Stuart, met with swarms of young * in 1863. Those of 1866 were very dense swarms of unknown extent. They did not do much damage, as there were but few farms then. They have hatched in different places in the Territory ever since, but have never been all over it at once or in any single year. Young broods begin to fly about June 15, and seem to begin to deposit eggs about July 15 to August 30. The prevailing winds at Deer Lodge are west and northwest, but the locusts always come with north and northeast winds. I have no doubt but that their flight is in a great measure governed by the direction of the winds.—[Granville Stuart.

HAMILTON, GALLATIN COUNTY, MONT., *May* 10, 1877.

SIR: In reply to the interrogations contained in circular No. 1, addressed to the postmaster at Hamilton, Mont., and received some days since, I beg leave to submit for the information of the commission such data concerning the series of topics set out in said circular, as well as any other information bearing upon that subject, as I am able at the present time to command.

As these inquiries have special reference to the year 1877, it will at once be obvious that but little positive information can be given, owing to the early date of this communication, and hence it will appear that prior years must form the subject of this communication.

It may, however, be proper to state that, in this immediate vicinity, no deposits of grasshopper eggs occurred during the season of 1866; nor, so far as can be learned, were there any within a distance of one hundred miles, on an east and west or north and south line from this locality.

The period designed to be covered by this paper is from July, 1875, to the present time. On the 4th of July of the foregoing year dense crowds of grasshoppers appeared in the air as early as 9 o'clock a. m. and at 3 o'clock p. m. commenced settling down, and soon covered the face of the whole country.

Their course was from the east and south. They have seldom, if ever, come from the north or west. These swarms continued for a period of twenty days, during which time they drilled the earth with eggs. In the following year, they commenced to hatch out about the 4th of April and continued hatching for a space of twenty days. As soon as they hatch, they commence to move at 9 o'clock a. m. and continue hopping until about 3 o'clock p. m., when they settle down for rest and feed until the following day, when they again commence marching as before, and so continue from day to day until they obtain wings, which is from the 4th to the 25th July. As soon as furnished with wings they move as before. When meeting with no adverse winds, or when the currents are favorable, they never light down until their day's journey is completed. Their velocity is increased in proportion to the force of the winds, and their height was unascertainable, even with the most powerful field-glass. The density of the swarms at certain periods of the day varied, generally the greatest between the hours of eleven and two o'clock.

The date of deposit of eggs has generally been from the 10th of July to the middle of August, and the following years they commence as before stated, hatching about 4th of April—from the 15th to 25th of April is the period when they hatch most numerously. This period, however, is slightly changed as the spring is early or late. In 1866, the proportion of eggs that failed to hatch was variously estimated from one-quarter to one-third.

In depositing their eggs, light sandy loam, or benches above the river bottoms are here chosen, and in this soil a larger portion hatch than in lower lands.

They acquire wings first about July 1 to 4, and in two or three days after are ready to fly. The wings which seem to be full grown are covered by a thin coating, drawn close around their bodies, and the work of cutting along their sides to expose them—requires but a few moments. This is done by the little hooked teeth, similar to a rotary saw, which cover the legs from the feet to the second joint, by pushing their legs backward horizontally with and along their sides, cutting the fibrous coating, at once exposes the double or back wings, which are equal in length to their entire bodies. As they first appear wet, a few minutes of sunshine is all that is required to dry them and they are ready for use.

The estimated injury to crops in Montana during the year 1866 from them was about 15 per cent.

The crops which suffered most were wheat, barley, and oats; those which suffered

* Near Bannack City is a stream named Grasshopper Creek, in 1862, from the large number of grasshoppers found on its banks. On the Yellowstone River, near where Bear River comes in, April 26-1863, the ground was almost covered with young grasshoppers.—[Journal of the Yellowstone Expedition of 1863, by James Stuart. (Contributions of the Historical Society of Montana, vol. 1.)

least were potatoes and pease. All these crops are protected from the young before they obtain wings, by means of ditches filled with running water surrounding the fields. These ditches are from 3 to 4 feet wide and 20 inches deep. As all the farm lands in Montana require irrigation, this process is universally adopted for protection against grasshoppers, as well as drought.

There are no means as yet known to prevent their devastation when they become full fledged.

As yet but little is known here of the effects of wild or domestic fowls upon these insects. Hens, turkeys, and many of the wild species of fowls are known to prey upon them, also a small ground-squirrel, quite numerous in the mountain region. But as these squirrels are destructive to grains and vegetables, the farmers destroy them in quantities by poisons. I may add, in conclusion, there were no eggs deposited here last season, consequently none are hatching, but it is not improbable we shall have immigrants during the month of July.

Respectfully submitted.

JOHN PATTEN.

A. S. PACKARD,
Salem, Mass.

FORT BENTON, MONT.,
August 4, 1877.

SIR: Respectfully referring to your circular No. 1, the following information is given referring to this particular character:

Question 4. July 1 to 5.

Question 7. Soft, loamy, and alkali.

Question 8. Soft, loamy, alkali, and rolling prairies.

Questions 9 and 10 cannot be answered.

The weather at time of hatching warm and moist, with occasional rain.

No swarms have yet appeared in this section, though they are reported 90 miles south of here in large numbers, coming from the east.

I will communicate further in a couple of weeks.

Yours, respectfully,

O. O. MORTSON.

UNITED STATES ENTOMOLOGICAL COMMISSION,
Saint Louis, Mo.

NOVEMBER 6, 1877.

SIR: I am sorry that a number of specimens of grasshoppers which I had procured to forward to you have, by an untoward accident, been destroyed, leaving me only able to reply to your circular No. 1.

1. Was answered by me in my former communication. No swarms arrived here since.

2. August 13 and 14, moderate swarms arrived from east-southeast. They were moving generally from 11 a. m. to 4 p. m. Temperature about 85° or 90° Fah., the air being *moist* and warm. I conclude that the swarms arriving here were only an offshoot from the large swarms which arrived about that time south of us about 100 miles, the mountain ranges having separated them.

3. As far as known to me, the month of July.

4. The latter end of May. I found a new hatching took place the latter part of September, this being in the valleys of the Belt Mountains.

5. The latter end of May and beginning of June.

6. Unable to give the proportion, but it must be this year nearly one-fourth, owing to prevalence of wet weather last spring.

7. Loose alkaline soil, generally on uplands.

8. Loose alkaline soil, generally on uplands.

9. August 6 to 13.

10. August 13.

11. Cannot answer, as little agriculture is done in this section.

15. Answered before.

16. None.

17. None.

18. Do not know of any.

19. This section always has suffered more or less each year. This year it has been lighter than usual, as the wet weather in spring retarded the hatching of the eggs and enabled vegetation to obtain a more mature growth, and thus resist their ravages better. Good crops are reported all through this section.

21. Little visibly, owing to the large number of insects. By personal observation, however, I conclude *all* the birds of this section make them their principal food.

In connection with this report I would respectfully draw your attention to the great change which the climate of Montana has been undergoing for the past three years, and which must exercise a vast influence on the production of this insect. In former

years there was generally a scarcity of rain from the middle of June to September. This last three years, however, the rain-fall has been greatly increased, especially in the month of July and early part of August. It has consequently increased the volume of rivers and creeks, created new springs, and hay has been cut this last two years of good quality where there was not even grazing before. This increase of damp not only retards the growth and hatching of the young insect, but also destroys an immense number.

O. O. MORTSON.

UNITED STATES ENTOMOLOGICAL COMMISSION,
Saint Louis, Mo.

FORT SHAW, MONT.,
December 26, 1877.

SIR: I have yours of the 1st instant, and regret exceedingly that it is not in my power to give you any satisfactory information in regard to the grasshoppers in this region. During the summer of 1876 they hatched out here and did the crops a great deal of harm, but I was absent during the whole summer on the Yellowstone and made no observations. Last summer I left here July 29, and left directions for observations to be made, so that the inquiries in your circular could be answered, but the matter was neglected, and now all the information I can get has to be collected from the men who had charge of the gardens during our absence, for we saw very few of the insects during our trip west of the mountains, our observations being more particularly directed toward catching "Joseph" and his band. I am told that last year the grasshoppers came here in large swarms during the first part of August, remained all summer, laid their eggs here, and died here, so that our prospects for next year are poor, the young insects being worse even than the full-grown ones in destroying the young crops. The only hope where the insects lay their eggs in any locality is in a prematurely early spring, when a spell of warm weather hatches out the eggs and is succeded by a sharp frost which kills them.

The insects last summer came here from the southeast, as we heard of them at Camp Baker, 80 or 90 miles southeast of here, before they got here, but they do not appear to have migrated from here at all. In their depredations cabbages seem to have suffered the least, and these were vigorously protected by one of our old soldiers, who broke off the large outside leaves and placed them over the plants. The grasshoppers eat these leaves, and hence did not destroy much of the head Potatoes and onions suffered most, and whenever the potato vines are badly eaten the tubers do not come to perfection and the potato is watery, a very unusual thing in this country, which is remarkable for its fine mealy potatoes generally.

I assure you I take very great interest in the labors of your commission and regret not being able to give you more information for its use. If you are able to do anything to rid this western country of these pests, you will perform a valuable service, and as we have but few Israelites in this country by letting go whom we might appease the Lord sending these pests, we shall have to depend upon science and patient investigations to get rid of them.

Respectfully, yours,

JOHN GIBBON,
Brevet Major-General, Colonel United States Army.

Prof. A. S. PACKARD,
Salem, Mass.

DIAMOND CITY, *August* 11, 1877.

DEAR SIR: Some time since I received your circular concerning the grasshoppers, and would have answered the questions sooner but for the fact until very recently there have been but few of the pests in the country.

In the western section of our Territory (Bitter Root Valley) the grasshoppers hatched out early in June and remained there until the 5th of July, when they began to depart, taking a southwesterly direction. They were detained several days longer in the country on account of frequent rain showers, which brought them down, and when they lit in swarms they did great damage to crops.

Ten or twelve farms, of 100 to 150 acres each were totally destroyed, while as many more were partially eaten up, reducing the yield of wheat in that valley about one-third.

In Eastern Montana there were no eggs deposited in 1876 and crops were firm and flourishing until the 24th of July, when they passed in by the millions in swarms from 500 feet to probably 2,000 feet high, and, when directly over the Gallatin and Missouri Valleys, they came suddenly down.

They all appeared to arrive in three or four days' time. They remained on the fields from three to seven days, in many instances completely destroying the crops.

The wheat in most places was too far advanced to be injured by them, but the barley and oat fields sustained a loss of at least one-third.

In the central portion of Montana there has as yet been but very slight damage. I would, at a rough estimate, put the loss of barley and oats by the 'hoppers in the whole Territory at only about one-fourth. This is light compared with other seasons. The past three years the crops harvested have been less than one-half.

The parasite is doing a great service in the destruction of the 'hoppers. In Bitter Root Valley, where they hatched out, the fly killed many of them. I noticed in many places after they left that the ground was literally covered with dead 'hoppers, and now here in Eastern Montana the number that are dying is enormous.

The 'hoppers are now depositing eggs in Eastern Montana but I have not learned of their arrival in any other sections than above named.

Have occasionally mailed a copy of our paper to you. Would be pleased to have statistics or summary of results of your commission when out, and will take pleasure in giving you further information if the movements of the 'hoppers develop anything further worthy of mention.

Truly, yours,

R. N. SUTHERLIN.

A. S. PACKARD, *Salem, Mass.*

DIAMOND CITY, *November* 18, 1877.

DEAR SIR: There were no eggs laid in the settled portions of Eastern or Central Montana in 1876. But in Western Montana (Missoula County), eggs were deposited in 1876, and in the following spring (1877) they hatched out and did a considerable damage to crops, but, when large enough, they flew away, and have not appeared again in that section of the country.

In Eastern Montana they came in from an easterly direction, and seemed to remain there, only traveling from one field to another. The valleys visited by them were Gallatin, Missouri, Crow, Creek, Jefferson, Sun River, and Madison. In these valleys they destroyed at least one-half of the barley and fully one-third of the oats. The wheat was so far advanced that they could do it but little damage.

In the valleys above named they have deposited an immense amount of eggs, and many of our farmers are troubled to determine as to how much seeding they shall risk. There was no damage by emigrant 'hoppers to crops in Deer Lodge and Missoula Counties, nor has there been any eggs deposited there.

Should you visit Montana again I would be glad to have you call upon me.

Very truly, yours,

R. N. SUTHERLIN.

Helena, Montana.—Swarms of locusts arrived July 28, 1877, at 8 a. m., the wind blowing from the southeast to northwest, the weather being clear. The directions of the locusts' flights were from the southeast, and they flew all day. None were hatched here this season, but they did in 1876. In former years they hatched most numerously in the beginning of May. This place has been visited more or less every year Birds, domestic fowl, wolves, foxes, badgers, skunks, bears, &c., feed on them.—[James Fergus.

Canton, Meagher County.—Locust swarms dense enough to cloud the sun arrived from 10 a. m. to 5 p. m., coming from the northeast; they depart in a southwest direction, the wind being north or northeast. Eggs were laid June 10, 1877; none hatched this year in this vicinity. They usually hatch in April. They acquire their wings July 1, and begin to fly off July 4 to 20. Two-row barley and oats suffer most. Six-row barley and wheat are the most easily protected. The young always move in a southwest course. In 1876 there were any amount of young, but no old ones. This locality has been visited every year since 1864 to 1876.—[William G. Tierny.

Mr. Ernest Ingersoll informs us that he saw swarms of locusts almost all the way from Helena to Fort Benton, for a distance of 60 miles, September 1–7, 1877.

NOTES FROM UTAH, OBTAINED BY DR. E. PALMER.

Information obtained from Joseph Bishop, of Adamsville, Utah, eight miles west of Beaver.—This place suffered much by grasshoppers. In 1855 they came; in August, 1866, they left. The crops of 1855 were nearly all destroyed, but 1855 crop good. In the fall of 1866 the grasshoppers made their appearance, laid their eggs, and these were hatched out in the spring of 1867, and for four years the crops might be said to be annihilated. The fifth year a little was saved; for instance, one man saved seven bushels from a twenty-acre field; another, five bushels from a forty-acre field. At this period there were twenty-six families residing at this place. They suffered a loss of 4,500 bushels of grain. The locusts seemed to like wheat, oats, cabbage, rhubarb; and they peeled the stems of the gooseberry. Barley and currents suffered less. The

grasshoppers left at this visitation the latter part of August. They hatched, in clay soil, late in May; but in the warmer sandy soil they hatched at the beginning of May. Of eggs laid in clay soil, one-third failed to hatch. Sandy soil was preferred to lay eggs in; but the grasshoppers would lay their eggs in the hard, traveled roads.

About the 1st of August they gained full wings. The unwinged 'hoppers were gathered by the bushels and fed to hogs, by digging pits and driving them in there; and they killed them by driving them into the water. Ditches were resorted to, the current carrying them to a bend in the ditch, where they were caught by brush or sacks by millions, taken out and destroyed or fed to hogs. The winged grasshoppers were destroyed more easily in the morning, as, while torpid, they would gather upon straw, sticks, and weeds that were laid for them to collect on; the fire was applied, and in this way vast millions were destroyed by fire.

Paragoonah, Utah, south of Salt Lake. Information obtained from Silas Smith, bishop of Paragoonah.—In 1871 grasshoppers came, laid their eggs, and in the following year hatched out; but half a crop saved. During the planting of the wheat and corn, the grains left uncovered were all devoured by the grasshopper. Lucern was eaten down to the roots. Some fruit-trees had their bark so stripped off that they died. But potatoes were not eaten in any settlement by 'hoppers. Previous to 1871 no information could be obtained.

I was informed that a woman saved fifty bushels of wheat from a five-acre field by drawing a rope across so as to touch the ears. As the grasshoppers moved, they were frightened away by the noise set up by several tin pans. Narrow paths at intervals were made through the wheat, so that they could march to and fro several time a day with the rope; the tin music thus saving what was very much prized during a scarcity.

Information obtained from Daniel Tyler, Beaver City, Beaver County, Utah—chief magistrate of Beaver, Utah.—In 1865 grasshoppers came first in the fall, and hatched out the next spring; but two-thirds of a crop was saved after fighting hard the vast horde. Ditches were dug, the grasshoppers (unwinged ones) were driven in and stamped to death, or the 'hoppers were driven into ditches filled with water, the current carrying them down to a bend, where they were caught in sacks or on brush by millions and destroyed. Rollers were much used to kill the unwinged ones. Fall plowing was resorted to in order to expose the eggs to the influence of frost, that they might be killed.

The winged ones were easiest killed, as they congregated on straw or brush while they were torpid in the morning by firing the same; several pits were dug, then the grass fired around them, smoke and heat driving the grasshoppers into the pits, the fire passing over singed them so that they could not fly, and they were easily killed.

The grasshoppers mostly hatched out in March or April. They laid their eggs wherever they lit. By July they had full wings. They left by September 1. Wheat suffered most; pease and potatoes they did not eat. The 'hoppers generally left with the wind southwest to northeast.

They were destroyed by three or four larvæ of insects in each 'hopper.

In 1866 the 'hoppers came again and laid their eggs, which hatched next spring, and for five years but little was saved, despite the efforts of the people, who were driven to the verge of starvation; every native plant and fruit that was at all eatable was used as food; many lived almost entirely on roots of wild plants.

This gentleman said that the crickets, that several years ago were so numerous and destructive about Salt Lake, were eaten in vast numbers by gulls. I was told that this same cricket was exceedingly destructive about Payson, Utah.

It seems to me that heat is a barrier to the southward distribution of grasshoppers, for their swarms have been fewer in number as they neared Saint George, Southern Utah, and some years they have not reached there, or if they did, were so few that they were not noticed. Beyond Saint George is a desert waste for 110 miles to the small settlement of Saint Thomas, Nevada, on the Muddy River. Before this settlement was formed, there was but a little very indifferent grass and few plants that would even tempt the grasshopper's appetite; and if an army of grasshoppers traveled over that waste of 110 miles the heat, that dries up the vegetation so that there is nothing green left, would by the intensity of its rays prevent their movements; besides, there is nothing for them to eat, only cactus and bitter or tough woody plants that they cannot eat. From all I can ascertain, Saint George may be concluded as the southern limit of the distribution of the Rocky Mountain locust.

I would remark that, previous to the settlement by whites, Utah must have been anything but a paradise for grasshoppers; for there was little or no vegetation, except along the streams. In traveling from one stream to another it was dry picking, the distances being often many miles and no vegetation. Now that the river bottoms are settled and cultivated by means of artificial irrigation from the rivers and crops raised, the grasshoppers thickly settle upon the same, as the artificially-raised crops are tenderer than the tough native plants of the dry desert. In early days, the Indians gathered many bushels of grasshoppers, and dried them for food; in fact, they considered the 'hoppers one of their best food-product. Of late, the Indians have decreased

in numbers, gathering fewer grasshoppers, as he has learned to relish better white man's food.

Information obtained from B. F. Johnson, formerly of Payson, now of Spring Lake, Utah.—Swarms of grasshoppers arrived about 4 p. m. Wind northwest to southeast. Wind variable, generally clear. Departure generally 10 a. m.; generally clear weather; the 'hoppers left in small swarms.

Eggs laid middle of August to frost; the time of hatching depended upon the warmth of the soil.

Plowing in winter failed to kill eggs. Eggs were more largely deposited in sandy and fine gravely soil.

They acquired their full wings about the time the wheat was in the ear—say the 10th of July. They moved off soon after their wings matured.

Payson had 100 families, which lost 1,500 acres of grain; half a crop saved: this was in 1855–'56. The grasshoppers coming in the fall laid eggs hatched in 1856, and did the damage in that year.

In the fall of 1855, grasshoppers made their appearance, laid their eggs ready to hatch the next spring, and for five years all crops except small patches were destroyed; the small patches saved was by patient labor; possibly one-fourth of a crop was saved. There were 200 families in Payson which had double the number of acres under cultivation that they put in in 1856.

Wheat suffered the most, then corn; potatoes, beans, pease, broom-corn, and sugar-cane suffered less. Large crickets made their appearance, not only in this but in the surrounding settlements, in great numbers, and helped the destructive 'hoppers to devour the crops. To kill unwinged locusts, rollers were very profitably used; and in the morning while they were torpid, and gathered together on straw or brush, they were destroyed by fire; ditches were dug, the unwinged 'hoppers driven in and beaten to death; they were often driven into ditches containing water and drowned. The winged ones were killed by burning and by driving them into pits dug for that purpose, and fire made around them, which, by its heat and smoke, drove the 'hoppers into pits, which, as they passed over, singed their wings, so that they were easily killed. They were also driven into ditches containing water, and carried down stream to a bend in the ditch, where sacks or brush caught quantities, which were easily killed. Often while plowing the corn the 'hoppers would carry it nearly all off. Pigeons destroyed a great many grasshoppers.

Information collected by John Vickers, of Nephi, Juab County, Utah.—This is an important locality, as it is surrounded by deserts, consequently locusts take hold vigorously and destroy the crops. Locusts came in 1854–'55 and 1867; they arrived from the north in the middle of the day, with a light wind from the north; they departed from the first to the middle of August. The young always hatch out the first week in April, and become fledged about July 1 and emigrate about August 15. In 1854 they eat every green thing, including grass and willows, and the people had to depend on replanting for their bread; at the other years they took about half the crops. The young insects always traveled toward the most tender vegetation without regard to direction. Various means were used to destroy the young locusts, such as driving them into water ditches, and catching them with gunny sacks, and burning them with straw; they were also driven into narrow ditches or pits, and then destroyed. The winged locusts were driven away with brush, while little good was ever done by birds, domestic fowl, or quadrupeds.

SMITHFIELD, CACHE COUNTY, *July* 26, 1877.

1. Swarms began to come about 2 p. m. on the 10th of August, 1876, and continued until the latter part of September, 1876.

a. Wind, a gentle breeze from the southwest.

b. Weather generally dry and clear; temperature about 90.

c. Flight, from the north a few degrees east; density, heavy, from the ground up as high as the eye could see; extent, over the entire neighborhood.

2. Swarms would depart about 10 a. m. the first or second day after their arrival; for the first ten or fifteen days after that they were more sluggish, and generally remained.

a. Wind, a gentle breeze from the southwest.

b. Temperature, 90; weather dry and clear.

c. Flight, generally south by west; density and extent not so heavy or numerous as the arrivals.

If the wind was strong the insects would not rise very high, and would fly only a short distance. The general time of departure was from 10 to 11 a. m., and arrival from 2 to 3 p. m., but on windy or cloudy days the departures and arrivals were small.

3. Eggs were deposited immediately on arrival.

4. Eggs were hatched most numerously from the 15th of April to the 15th of May, 1877.

5. Eggs were hatched in previous years, generally about the same time as the present year.

6. From appearances every egg that was deposited hatched.

7. The eggs were mostly deposited in a sandy, gravelly soil.
8. The young were most numerously hatched on sandy, gravelly soil and uncultivated.
9. The first insects acquired their wings from the 1st to the 5th of June, 1877.
10. June 10 they first began to migrate, but the distance traveled was short and the numbers limited.
11. In this district about one-fourth the crop.
12. The wheat-crop suffered most.
13. Pease are most easily protected.
14. Pease and rye suffered least, also fall crops.
15. The young insect generally travels south and west unless headed by streams or insurmountable obstacles, such as marshy or barren lands.
16. The means employed for their destruction are numerous: in the early stages, driving on to straw and burning, a brush-drag on dry cultivated lands; advanced stages, dry ditches from two to four feet deep, sloping under on the side next to the crop, and pits in the ditch every one or two rods, about three feet deep, narrow in the bottom; in this last method hundreds of bushels have been destroyed; by burying them in the pits, and then digging others; another method is to drive them into running streams, catch them in sacks and bury them; in this way large quantities have been destroyed; the dry ditch is a good protection against their ravages.
17. We have not been able to protect our crops against or destroy the winged insects.
18. We have not employed any mechanical means to any great extent, and are therefore unable to report how far they might be useful.
19. We were visited in 1876.
20. We were visited in the years 1866, 1867, 1868, and 1869, the first visitation being on the 10th of September, 1866; the crops were totally destroyed in 1867, and partially in 1868 and 1869.
21. Domestic chickens have been very useful in destroying grasshoppers in gardens, &c., and on some parts of the farming land, but not to any great extent.
22. On the 10th of September, 1866, was the first invasion I know of; cabbages, turnips, and a few late vegetables were destroyed; the grain was mostly cut and in the stack; they continued to arrive for some time that fall, depositing their eggs, which were hatched the following spring.

In 1869 large numbers of the insects were destroyed by a parasite eating their vitals. I am informed the parasite is formed by a small black fly depositing an egg in the grasshopper. A few have died in this manner this year.

Respectfully,

FRANCIS SHARP.

Prof. A. S. PACKARD, JR.

LOGAN CITY, CACHE COUNTY, UTAH, *June* 15, 1877.

DEAR SIR: I have lived in Utah since 1852, but have not kept a correct journal of the grasshopper invasions. But in the fall of 1854 they came from the north and laid their eggs and then swarmed the country in the spring of 1855, and eat up three-fourths of the crops in Utah. They came from the same direction in the fall of 1866, and eat up about one-half of the crop of Cache County; they came again in the fall of 1876 from the same direction. They hatch when the weather becomes warm, and after a little rain they commenced to fly, this year, about the 1st of June. They eat about one-third of the crops this year in this county. They hurt pease less than anything. They commence flying about 10 o'clock a. m., with a little breeze from the south; they travel south by wings, but this spring they hopped to the west a little south. They lay their eggs mostly in clay land. I have proven the best mode to save crops to be to dig holes and drive them into them and bury them. A large proportion of the crop has been saved by ditching and digging holes in the bottom of the ditch about a rod apart.

One year they drifted into Salt Lake, and it was a well-known fact that at one point they drifted ashore and piled up on the beach six feet high and two miles long.

I remain, yours,

HENRY BALLARD.

Prof. A. S. PACKARD, Jr

HEBER CITY, WASATCH COUNTY, UTAH,
July 23, 1877.

SIR: In answer to your communication in regard to the grasshopper habits, &c., the following is the best information that I can obtain from farmers and others living in this county.

They fly from 10 a. m. to 4 p. m., from northeast to southwest, light breeze, generally with the wind.

Departure in July and August, carried by a light breeze, generally clear weather. In the summer of 1868 they were like a cloud between us and the sun, and when the

wind subsided the grasshoppers dropped to the earth, covering every thing, trees, fences, and vegetation generally. None appeared this year, and have not been any since 1870. They used to hatch early in the spring on the sunny slopes, in May and June. They would lay their eggs in the fall on sunny slopes and in hard level land. The highways were full of holes made by them and filled with eggs. They are able to fly by the last of June and in July. The damage done to crops in this county was very great, considering the small population in 1868. Corn, oats, wheat, barley, potatoes, and onions, they are particularly fond of. Pease are not molested by them if other vegetable matter is attainable. Damage done in 1868 could not be less than $50,000 in this county. The only means at all effectual in keeping the young hoppers off (*that is before they fly*) has been ditches around the field, filled with water. Domestic fowls have been tried, but not to do any good.

A gentleman living in Provo, Utah County, in the summer of 1868, fearing famine, determined to fight the young horde hatched around the fields. He commenced to protect a twenty-acre field, and to do so got several wagon-covers, large sheets, and two persons with each sheet went to work taking hold of two corners, dragged the sheet over the field; as they went along the 'hoppers jumped up several feet in the air and dropped on to the sheet. This method he followed up daily, as long as the 'hoppers lasted. He caught near 50 bushels of them and buried them, tramping the earth hard over them, and saved his wheat while every body else lost theirs.

Respectfully,

CHS. SHELTON.

Prof. A. S. PACKARD.

Plain City, Weber County, Utah.—The locusts generally came with a gentle breeze to the northeast, in clear weather, from 11 a. m. till 4 p. m. In height as far as the eye could reach, and in size from a few square rods to miles in extent. They left June 15, 10 a. m., flying with the wind, the weather being warm and clear. Until this year they have flown southwest, but this season to the northeast. The eggs hatched this year unusually late, many not until June. In former years they have hatched when vegetation started in April. About three-fourths of the eggs failed to hatch; but opinions differ as to the cause. The eggs were deposited principally in sandy soil, where they also hatched earlier. The first winged forms were seen about June 1, and they began to migrate June 10. The damage cannot be estimated at present, but whole regions are devastated. They seem to relish especially onions, turnips, radishes, &c.; the more pungent the more relished. Sorghum and pease are left when other things are within reach. The methods employed for their destruction have been laying down straw and burning when they have perched for the night; digging trenches and driving them in; but the most effectual method was plowing them under before they had acquired wings. Our region was visited in 1876, but not to such an extent as in former years. The first invasion was in 1855, then a skip of twelve years; considerable damage in 1867, 1868, 1869; in 1870, all vegetation destroyed. On a small area, chickens will destroy them when first hatched. There are no printed records within reach.—[John Spiers.

Ogden, Utah.—Swarms arrived July, 1856, with a northeast tempest, the weather being hot and clear. The direction of the flight was west. They remained and laid their eggs in dry and sandy soil in October, and apparently nearly all hatched. The young acquired wings in July. In 1875, the crop of lucern hay and corn destroyed; wheat, oats, and barley suffered little. The young went east. Burning, digging ditches, and drowning have been employed for their destruction. This region has been visited every year from 1863 to 1870. No records at hand.—[John I. Hart.

Payson, Utah County, Utah.—Swarms usually came in the afternoon with a south or southeast wind, in clear weather. They fly very high and in swarms so dense as to darken the air. They leave in the forenoon in the same manner that they come. No eggs were deposited or hatched here this year. The eggs are usually laid in dry, hard gravelly soil, and the young acquire wings in June. They destroy all crops nearly equally, sorghum a little less than the others. Ditching and burning have been tried for their destruction, but are not satisfactory. Not visited in 1876.—[Isaiah M. Combs.

Corydon, Morgan County, Utah, August 11, 1877.—Eighteen hundred and seventy-seven is the first year since 1868 and 1869 of grasshoppers. They came in swarms or patches last fall (October), and laid in hard or unplowed ground. They hatched in June, but appear to be at different times as full-grown, and different sizes are to be seen. They all work south before taking wing, afterward fly north. None have left this place to date; none have arrived from other places. Reports that after full wings a great many die from gnats. At present grain has not suffered, but all lucerns and tame hays were destroyed. Many are seen on heads of grain, but the leaves are all that are gone at present.—[Chas. Buntine.

Ranch, Utah, July 27, 1877.—In 1876 the grasshoppers came onto Cañon Creek, three miles south of Salt Lake City, about the 20th of September, keeping close to the mountain on the east side of the valley; they seemed to come down the cañons from the

east, shaping their course to the south after they came into the valleys. It is the general opinion that they came up Weber Cañon and Valley, and crossed over the Wahsatch Mountains; observations for several years show them to come the same way each year. They commenced laying on their arrival; usually laid their eggs on hard, stony ground or gravelly knolls, preferring the latter places to mellow or loamy soils. In 1877 commenced hatching 2d day of May; the bulk of them hatched about June 1, and were still hatching June 11. They have been known to lay their eggs in July, which eggs would hatch the same season when they were laid in warm, sandy locations. Generally hatched about May 1, before snow-storms had ceased. All of the eggs appear to have hatched this year. In previous years would fly in June. When they leave they go southwest, often carried into Great Salt Lake by the south wind. Crops that suffer the most are cereals—corn, lucern, onions, tomatoes, pepper, cabbage. They never injure sorghum after it is knee-high; will eat clothing in preference to sorghum. Trapping in water-ditch, in baskets or sacks, and burying. The only means of starting them on the wing is to drive them. When they are ready to emigrate they seem to take wing on a signal; one of them will rise up in the air with a whirring sound for a few seconds, when those within hearing of the sound will begin to rise, and they rise in a larger circle until the whole flock have taken wing. Many die before they lay their eggs; have seen as high as five maggots in a grasshopper. Grasshoppers laid their eggs in 1854, 1855, 1856, and 1876. Those hatched in 1877 are not like those of previous seasons; they seem to be smaller; the eggs seem smaller; the eggs grow clear and enlarge previous to hatching.

The above notes taken during conversation with Bishop W. C. A. Smoots, at Paper Mill Post-office, Utah. About six per cent. of the eggs laid in 1876 have failed to hatch this season, owing to being shaded by lucern and on moist soil. Commenced in previous years to fly about July 1 to 15; bulk took wing about July 10. There is a grub preying on their eggs. They usually start to fly, when they migrate, about noon, choosing open fine weather always to fly, so as to resemble a snow-storm. In 1868 and 1869 they destroyed everything on the brush land. When first hatched they inclined to go south, but as they grow older they will change their pasturage. Have been observed to stop for a few minutes and turn at right-angles and march forward to a wheat-field a half mile off. In 1856 three hundred and eighteen bushels were destroyed in three days with the help of ten persons. Method of killing was burning and burying. Sheep have been very useful in destroying them; have known 75 per cent. destroyed by sheep before they got wings.

The above statement is from Mr. Charles I. Robson, Paper Mill Post-office, Cañon Creek, Salt Lake County

Mr. Casper, Brenton's Post-office, answers as follows:

5th question in circular. April, in 1854 and 1855. 8. Bench, adobic, and gravelly ground. 9. Last days of June. 10. Last days of June wheat had been eaten up, and corn was planted 29th of June. 11. Ninety per cent. 12. Cereals, corn, potatoes, &c. 13. None. 15. South; go straight along; will cross running streams. 16. Dug ditches, burned, trapped in sacks. 17. No means an entire success. 19. By only a few late in the fall. 21. Sea-gulls have been very destructive to the 'hopper.

Statement of Mr. William Casto, sane post-office, eleven miles south of Salt Lake City: In July, 1853, the first grasshoppers came into Salt Lake County. Most of them were at Haliday's Settlement (residence of Mr. Casto). They came from the east about noon. (I saw them on the Cache la Poudre, between Laramie and North Fork of the Platte, in 1847.) Prefer a gentle breeze from the east or north to travel in; always fly in bright, clear weather. When they alighted in 1853, would cover the ground an inch deep.

In 1852 they went in a westerly direction, but spread out a great deal; they will not travel against a head wind or in cloudy weather; they rise about 10 o'clock a. m. 5. In April, if very warm; in favorable locations about March 20. 7. Dryest, gravelly, and clay soils. 8. Same. 9. In July. 10. In July about 1st; planted garden the 4th of July and raised vegetables. 11. Eighty per cent. 12. Wheat and corn. 13 and 14. Potatoes. 15. To the nearest grain-fields from hatching-grounds; will not eat sorghum until other supplies are exhausted. 16. Trapping in ditches, with sacks hung over wheat, and killing them on clover in the morning. 17. Driving in swift running ditches, and trapping with sacks and burying them. 19. No. 21. Have been very destructive, but hardly perceptible.

Bishop J. McCullough's statement, Alpine City, Utah County, thirty miles south of Salt Lake City: 5. Generally latter part of April and May. 7. Waste lands, roads, sides of roads, and travel for the nearest wheat-patch. 12. Small grains, vegetables; *not very fond of sorghum.* 13. Pease and sorghum. 15. South, but will move in every direction to obtain pasturage. 16. Driving into straw and burning; brushing with heavy brush. Sheep are very efficacious. 19. No. 20. Yes, in 1854 and 1855. 21. Chickens ahead of other birds or animals. We have saved our grain by water ditches, and have trapped in sacks in ditches, and have buried bushels in pits.

While in San Pete County and traveling up the Saven River to this place, fifteen

miles south of head waters of Saven River. I have sought to add any further information to the above statement, but I find that every fact that I have been able to glean is obtained in the above statements.—[Andrew L. Siler.

Saint John's, Tooele County, Utah, July 11, 1877.—I am sorry that I am unable to send you all the information required in regard to the grasshoppers and the ravages committed by them, as we have not kept any record relating to those matters. From recollection I can state that in this settlement great swarms of grasshoppers came here in the latter part of the summer of 1867 and deposited their eggs mostly on the bench land west of the settlement. The nature of the soil is mostly a sandy loam. In the spring of 1868 the eggs were hatched out and immense multitudes of the young 'hoppers covered the cultivated fields, and in many instances made a clean sweep of every kind of vegetation as soon as it came up through the ground. Some few of our farmers fought the pest, some by trenching, with here and there holes dug in the bottom of them, and then taking the young in bags and destroying them. The most effectual plan adopted by others was to place many small heaps of straw over the fields in the afternoon, and then, in the evening, pass through, men, women, and children, and with noise and sometimes drawing a rope over the land held by the ends, and by this means the young were caused to go into the heaps of straw, which was then set fire to, burning straw and the 'hoppers. Several of the people succeeded by this means in saving a portion of their crops. When fledged the grasshoppers gathered in dense multitudes, on the prairie and along the roadsides for miles, and at some signal seemingly they rose and ascended up to a considerable height, and, I believe, went south, or nearly so.

In the fall of 1869 we were again visited with them, *i. e.*, the grasshopper eggs were laid in the fall; the results in the spring of 1870 were much the same as above mentioned for the year 1 68. The same methods were resorted to in fighting them, with much better results, a much greater portion of the crops having been saved.

Last fall a few 'hoppers were seen near the settlement, and this spring we find that two or three fields of wheat have been troubled with the young pest. By a resort to the old method of laying straw in small heaps over the land they have been burnt up, so that but very few remain, and the damage done will not amount to much. Should we be again visited with these destroyers will endeavor to note and record, so that we may be better able to aid the commission in their labors.—[Geo. W. Burridge.

Spanish Fork City, Utah County, Utah, September 4, 1877.—As I resided here the summer of 1855 and saw the effects of their ravages, I will give a few answers to the questions contained in the circular from memory, without, however, any memoranda of dates to refer to.

Question 1. They commenced coming in swarms early in July, usually alighting from 1 o'clock p. m. until near sunset; the wind being from north, northeast, or northwest, and all swarms came from this direction; weather generally clear, and if the wind was blowing heavy or strong there were no swarms flying. 2. Swarms when raising to fly generally in the fore part of the day, but sometimes as late as 2 o'clock p. m., and invariably continued their course to the southward.—[George D. Snell.

Kanab, Kane County, Utah.—Swarms of locusts arrived from the southeast August 10, 1871, at 10 o'clock, the wind being southeast, blowing half a gale. They departed in large swarms August 15, 1871, at 2 p. m., in a northeast [probably southwest was intended] direction. No eggs were deposited in 1877. They hatched most abundantly in March, 1875, and became fledged in May. Since 1871 they have done us no special harm.—[W. J. Johnson, jr.

Silver Reef, June 16, 1877.—Grasshoppers migrated very largely to this section some five or six years ago; there were no eggs deposited to amount to anything. The insects came from the north and did much damage to orchards, vineyards, and gardens.—[C. E. Johnson.

Saint George, Utah.—We had a light visitation from the north in 1869, and a few in 1870; none others for over twelve years.—[J. E. Johnson.

NEW MEXICO.

RANCHOS DE TAOS, NEW MEXICO, *July* 11, 1877.

As requested, I send you the answers to your inquiries regarding the Rocky Mountain locust.

First swarms of grasshoppers arrived in September, 1875; deposited eggs in a few places; hatched in March and April, 1876; destroyed crops in a few townships, and left latter part of July, 1876.

Answer to circular: 1. Swarms arrived again from August 20 to September 30, some days swarms so large that the sun could not be seen for an hour at the time; deposited eggs in October and November, 1876. 1 *a*. Wind most prevailing at the time northeast. 1 *b*. Weather warm and clear. 1 *c*. Southwest, large swarms. 2. Left here about November 5; generally commenced rising about 10 o'clock a. m. 2 *a*. A little west of south. 2 *c*. Dry and rather warm for the season. 3 *c*. Southwest. 3. None yet. 4. Eggs commenced hatching in February; brood died; hatched again in March and mostly died; were hatched very numerously during April and May, and a

few hatching in June, and even up to this date. 5. Some in March, but mostly in April, 1876. 6. Not one-tenth were hatched; ground wet. 7. Deposited in all kinds of ground from black clay to solid gravel. 8. On gravelly side-hills and upland prairie. 9. About June 10. 10. Commenced migrate about July 5. 11. Injury, at lowest estemate, in Taos County, $500,000, and probably three times as much in the Territory. 12. Wheat, but destroyed everything, only very little corn and a few pease left in the whole county. 13. None. 14. Pease. 15. In all directions, where anything could be found to eat. 16. Catching on large sheets with a hole in center, to which a cotton sack is sewed. Thousands and thousands of pounds were caught this way, but very unsatisfactory, as expenses are nearly as much as crops will come to. 17. Nothing, as there are no crops to protect. 18. None. 19. Yes. 20. Gave before. 21. Not at all, as locusts were so plenty that chickens and turkeys would not eat them.

The grasshoppers are dying very fast, by the millions; a small gray fly is killing them. They have all a small white grub inside after death. I send you by to-day's mail a small box with grasshoppers, also one of the gray flies. The grasshoppers are all sizes.—[Alexander Gusdorf.

APPENDIX XXVI.

LIST OF CORRESPONDENTS WHO HAVE ASSISTED THE COMMISSION, ARRANGED ALPHABETICALLY BY STATES, AND EITHER ALPHABETICALLY BY NAME OR BY POST-OFFICE ADDRESS, WITHIN THE STATES.

ARKANSAS.

J. W. Williams, Bentonville.
W. Stephenson, Bentonville.
F. Finley, Bentonville.
G. Osborne, Bentonville.
J. L. Sims, Carrollton.
L. Munnally, Carrollton.
Hon. T. M. Gunter, M. C., Fayetteville.
W. M. Fishback, Fort Smith.
P. K. Roots, Fort Smith.
Hon. Lucien C. Gause, M. C., Jacksonport.
H. S. Reynolds, Judsonia.
J. H. Neubern, Little Rock.
J. P. Russell, Little Rock.
O. F. Sheldon, Little Rock.

BRITISH AMERICA.

Lieut. Garr. Laird, Battleford, Northwest Territory.
Hon. M. Ryan, Battleford, Northwest Territory.
J. B. Maloney, Battleford, Northwest Territory.
Captain Walker, mounted police, Battleford, Northwest Territory.
Mr. Dickinson, Indian superintendent, Battleford, Northwest Territory.
John Little, telegraph office, Battleford, Northwest Territory.
Stewart D. Mulkins, Battleford, Northwest Territory.
Charles Steward, Boyne, Manitoba.
Kenneth McKenzie, Burnside, Manitoba.
Major Walsh, post-commander, Cypress Hills, Northwest Territory.
John G. Kittson, M. D., Cypress Hills, Northwest Territory.
H. Belanger, Cumberland, Northwest Territory.
F. T. Bradley, East Lynne, Manitoba.
U. L. Wood, Edmonton, Northwest Territory.
Mr. Lawrence Clark, Fort Carleton, Northwest Territory.
H. McDonald, Hudson Bay factor, Fort Ellice, Northwest Territory.
Col. H. McLeod, Fort McLeod, Northwest Territory.
W. B. Hall, Headingly, Manitoba.
Hon. McDonald Gunn, Lower Fort Garry, Manitoba.
C. P. Brown, Palestine, Manitoba.
W. Lairy, Point de Chiene, Manitoba.
A. C. Harvey, Poplar Point, Manitoba.
His Lordship Bishop of Saskatchewan, Prince Albert, Northwest Territory.
Mr. Moore, Prince Albert, Northwest Territory.
Captain Moore, Prince Albert, Northwest Territory.
Mr. McLean, Hudson Bay factor, Quappelle, Northwest Territory.
R. Miller, M. D., Swan River Barracks, Northwest Territory.
R. H. Claire, Westborne, Manitoba.
William Nimmons, Winnipeg, Manitoba.
Hon. Donald Gunn, Winnipeg, Manitoba.
J. Stewart, Winnipeg, Manitoba.
Consul J. W. Taylor, Winnipeg, Manitoba.
Bishop Taché, Winnipeg, Manitoba.
Gov. A. Morris, Winnipeg, Manitoba.

CALIFORNIA.

R. E. C. Stearns, Berkeley, Alameda County.
J. H. Sisson, Berryvale, Siskiyou County.
Thomas Birmingham, Big Trees, Calaveras County.
Lorenzo G. Yates, Centreville, Alameda County.
John Bidwell, Chico, Butte County.
W. S. Green, Colusa, Colusa County.
J. L. Crittenden, Hill's Ferry, Merced County.
E. W. Buffum, Hornitos, Mariposa County.
S. W. Carr, Hornitos, Mariposa County.
Thomas Givens, Hornitos, Mariposa County.
Judge McClury, Hornitos, Mariposa County.
Prof. W. A. Saunders, Kingsburg, Fresno County.
Pentland Brothers, Knight's Ferry, Stanislaus County.
John Wasley, Linden, San Joaquin County.
W. Webster, Oakland, Alameda County.
I. N. Hoag, Sacramento, Sacramento County.
George Rich, Sacramento, Sacramento County.
J. W. A. Wright, Sacramento, Sacramento County.
James Behrens, San Francisco, San Francisco County.
William Boericke, San Francisco (234 Sutter street), San Francisco County.

A. C. Bradford, San Francisco (808 Montgomery street), San Francisco County.
Henry Edwards, San Francisco, San Francisco County.
T. H. Goodman, San Francisco, San Francisco County.
Arthur B. Stout, San Francisco (box 429), San Francisco County.
Edward J. Wickson, San Francisco, San Francisco County.
Elwood Cooper, Santa Barbara, Santa Barbara County.
Dr. C. Grattan, Stockton, San Joaquin County.
E. W. Holden, Stockton, San Joaquin County.
G. Ladd, Stockton, San Joaquin County.
W. L. Overhiser, Stockton, San Joaquin County.
W. G. Phelps, Stockton, San Joaquin County.
Cuther Salmon, Stockton, San Joaquin County.
P. D. Wigginton, Stockton, San Joaquin County.
Andrew Wolfe, Stockton, San Joaquin County.
S. B. Sears, Stockton, San Joaquin County.
W. L. Morton, Tulare, Tulare County.
John Graves, Visalia, Tulare County.
R. C. Sargent, Woodbridge, San Joaquin County.
S. V. Treadway, Woodbridge, San Joaquin County.
Galen Clark, Yosemite, Mariposa County,
John Oleyer, Yuba City, Sutter County.
Mr. Cowley, Victoria, Vancouver Island.
Prof. F. Sumichrast, Santa Ephigenia, Mexico.
R. Minter d'Oca, Hospital Real, No. 3, Mexico.
Prof. Dugés, Guanajinto, Mexico.
Dr. Earl Flint, Grenada, Nicaragua.
Col. James Hendrick, Grenada, Nicaragua.
Francis G. Sarg, care Hockmeyer & Ritscher, Guatemala.
Manuel Medina, Merida, Yucatan.

COLORADO.

P. A. Leonard, Boulder.
John A. Ellet, Boulder.
J. P. Lescher, Boulder.
Joseph Wolff, Boulder.
J. B. Long, Boulder.
W. A. Helm, Cañon City.
H. C. McAllister, jr., Colorado Springs.
B. S. Lake, Central City.
A. H. Arnett, Denver.
C. L. Campbell, Denver, Arapahoe County.
E. A. Kessler, Denver.
Benjamin H. Smith, Denver.
Gov. J. L. Rowett, Denver.
J. S. Stanger, Denver.
Aug. Jacob, Denver (care of F. J. Bancroft, M. D.)
Sergeant J. A. Barwick, Denver.
H. H. Ellwood, Denver.
William Holley, Del Norte.
W. O. Wise, Erie, Weld County.
J. A. Pace, Evans.
R. O. Tenney, Fort Collins.
W. F. Watrous, secretary Agricultural College, Fort Collins.
H. Stratton, Fort Collins.
W. H. H. Loveland, Golden.
H. W. Pollitz, Georgetown.
G. B. Hight, Greeley.
David Boyd, Greeley.
H. Smith, Greeley, Maple street.
Benjamin Eaton, Greeley.
A. E. Gibson, Greeley.
Daniel Hawkes, Greeley.
J. M. Clark, Greeley.
Florry & Co., Greeley.
B. F. Grange, Greeley.
Joseph Ramsay, Greeley.
Louis Wyatt, Greeley.
T. M. Trippe, Hermora, La Plata County.
A. A. Fuller, Hermora, La Plata County.
William McLelland, Julesburg.
C. H. Marsh, La Porte.
E. N. Garbutt, La Porte.
M. R. Leverson, Larkspur, Douglas County.
C. S. Brown, Pleasant Valley, Fremont County.
Judge Hallett, Pueblo.
A. C. Rupe, San Luis.
W. B. Felton, Saquache.
Col. Charles B. Lamborn, South Pueblo.
J. C. Abbott, Wheatland.

DAKOTA.

D.T. Flannery, Bismarck, Burleigh County.
Linda W. Slaughter, Bismarck, Burleigh County.
George H. Sweet, Bismarck, Burleigh County.
Col. W. Thompson, Bismarck, Burleigh County.
G. H. Walsh, Bismarck, Burleigh County.
D. P. Bradford, Bonhomme, Bonhomme County.
G. S. Codington, Dell Rapids, Minnehaha County.
William T. Hill, Dell Rapids, Minnehaha
M. D. L. Pettigrew, Flandreau, Moody County.
G. W. Santee, Forestburg, Bramble County.
Colonel Moore, Fort Buford, Howard County.
Dr. Blair D. Taylor, Fort Rice, Morton County.
Dr. C. E. McChesney, Fort Sisseton, Deuel County.
A. I. Comfort, Fort Sully, Sully County.
Capt. Leslie Smith, Fort Sully, Sully County.
Capt. A. A. Harback, Fort Totten, French County.
Lieut. L. Hunt, Fort Totten, French County.

Lieutenant White, Fort Totten, French County.
H. H. Herrick, Gary, Deuel County.
J. H. Prosser, Gary, Deuel County.
Haloor Berg, Grand Forks, Grand Forks County.
Hector Bruce, Grand Forks, Grand Forks County.
D. M. Holms, Grand Forks, Grand Forks County.
George H. Walsh, Grand Forks, Grand Forks County.
H. H. Platts, Hillsdale, Moody County.
Merrick Moore, Jamestown, Stutsman County.
I. A. Foswick, Lake Village, Brookings County.
Capt. L. D. D. Russey, Lower Brule agency.
J. H. Lau, Madison, Lake County.
C. W. Wright, Madison, Lake County.
Rev. G. S. Codington, Medary, Brookings County.
S. M. Daball, Olivet, Hutchinson County.
A. S. Jones, Olivet, Hutchinson County.
John Maxwell, Olivet, Hutchinson County.
W. B. Goodfellow, Pembina, Pembina County.
Butler Olson, Pembina, Pembina County.
F. B. Foster, Rockport, Hanson County.
J. M. McBride, Rosedale, Hanson County.
J. W. Hall, Saybrook, Clay County.
John Stafford, Scotland, Hutchinson County.
N. Clark, Sioux Falls, Minnehaha County.
T. C. Everett, Sioux Falls, Minnehaha County.
Rev. S. R. Riggs, Sisseton agency, Richland County.
S. Hitchcock, Springfield, Bonhomme County.
Rev. Abbot Martin, Standing Rock, Boreman County.
S. F. Andrews (township 97, range 54), Turner County.
D. W. Smith, Wahpeton, Richland County.
George Emerling, Walhalla, Pembina County.
Miss Ernestine Mager, Walhalla, Pembina County.
L. D. Marsh, Worthington, Barnes County.
C. R. Bates, Yankton, Yankton County.
A. W. Barber, Yankton, Yankton County.
B. C. Jacobs, Lincoln County.

IDAHO.

Rev. William Ballard, Boise City, Ada County.
General L. F. Carter, Boise City, Ada County.
Alexander Stalker, Franklin, Oneida County.
General C. C. Rich, Paris, Bear Lake County.

IOWA.

Prof. C. E. Bessey, Ames, Story County.
H. C. McCoy, M. D., Algona, Kossuth County.
Crowell & Thompson, Alta, Buena Vista County.
W. J. Newell, Athol, Sioux County.
John L. Barry, Barryville.
Andrew Barr, Carroll.
William Tucker, Chickasaw, Chickasaw County.
William Larrabee, Clermont, Fayette County.
J. L. Oliver, Clinton.
A. Adams, Dakota City, Humboldt County.
C. C. Parry, Davenport.
M. H. Wigant, Denison.
G. B. Brackett, Denmark, Lee County.
William H. Fleming, Des Moines.
John Patten, Des Moines.
C. L. Watson, Des Moines.
G. H. Warner, Des Moines.
Maj J. L. Rochussen, Emporia.
John Walker, Emmetsburg, Palo Alto County.
D. L. Watson, Ellis.
C. W. Jarvis, Estherville, Emmett County.
J. M. Shaffer, Fairfield.
J. F. Duncombe, Fort Dodge, Webster County.
Mrs. J. Swain, Fort Dodge, Webster County.
A. W. Hoffmeister, Fort Madison.
Mrs. C. J. Peabody, Hazard, Cherokee County.
G. C. Garpenter, Indianola.
J. N. Weeks, jr., Iowa Falls, Hardin County.
A. N. Jack, Lake City, Calhoun County.
J. M. Jenkins, LeMars.
A. H. Gleason, Little Sioux, Harrison County.
Rev. J. R. Brown, Malvern, Mills County.
T. M. Alstrop, Malvern, Mills County.
W. K. Follett, Malvern, Mills County.
A. J. Boston, Malvern, Mills County.
A. Burkheimer, Malvern, Mills County.
Charles Thompson, Maple Valley, Buena Vista County.
James Root, jr., Marengo.
A. B. Holms, Mount Hope, Sac County.
F. M. Witter, Muscatine.
E. G. Day, Nevada, Story County.
J. L. Frazier, Nevada, Story County.
O. E. Strong, Pocahontas Centre, Pocahontas County.
S. J. Morris, Princeton.
C. Longshore, Pringhar, O'Brien County.
Caleb Brown, Rose Hill, Mahaska County.
Washington Allen, Sac City, Sac County.
J. C. Elliot, Sheldon, O'Brien County.
T. W. Bashford, Sheldon, O'Brien County.
W. H. Brown, Shelby, Shelby County.
G. V. Swearingen, Sidney, Fremont County.
James Knox, jr., Sidney, Fremont County.
T. G. Stevenson, Sidney, Fremont County.
E. W. Skinner, Sioux City, Woodbury County.

William R. Smith, Sioux City.
A. A. Mosher, Spirit Lake, Dickinson County.
J. F. Sanborn, Tabor, Fremont County.
J. E. Todd, Tabor, Fremont County.
D. W. Adams, Waukau.
C. Aldrich, Webster City.
V. W. Hollingsworth, West Branch.
E. H. King, West Liberty, Muscatine County.
H. C. Warner, West Union.

KANSAS.

Thomas Nixon, Argyle, Sumner County.
C. W. Johnson, Atchison.
H. P. Stebbins, Atchison.
J. C. S. Murphy, Barrett.
E. M. Sanford, Burlingame, Osage County.
B. L. Kingburg, Burlington, Coffey County.
W. Flint, Chitopa, Labette County.
J. P. Heaton, Belleville.
P. J. Thwaites, Coyville, Wilson County.
A. G. Chase, Easton, Leavenworth County.
S. C. Delays, Emporia.
J. W. Chandler, Emporia.
Robert Milliken, Emporia.
L. M. Chamberlin, Ellinwood.
T. H. Watson, East Norway, Doniphan County.
John W. Robson, Cheever, Dickinson County.
C. G. Brooks, Cherryvale, Montgomery County.
W. M. Robson, Claytonville.
J. Brown, county clerk, Fort Scott, Bourbon County.
F. E. Wilcox, Fort Leavenworth.
Mr. Connor, Frankfort, Marshall County.
S. C. Carley, Fredonia, Wilson County.
Herbert C. Sunderland, Gaylord, Smith County.
H. J. Evans, Great Bend, Barton County.
D. B. Skeels, Galesburg, Neosho County.
J. H. Lanter, Garnett.
L. H. Osborne, Garnett.
H. E. Van Deman, Geneva.
Brown Brother, Guilford, Wilson County.
C. W. Johnson, Hiawatha.
E. M. Pratt, Hiawatha.
E. Snyder, Atchison.
Robert Hay, Holton.
F. A. Root, Holton.
Fred. Stewart, Humboldt.
S. T. Kelsey, Hutchinson.
J. W. Bagby, Ioben, Clay County.
H. F. Rice, Iola.
Harmon Scott, Iowa, Allen County.
B. T. Ward, Irving, Marshall County.
Mr. Preston, Irving, Marshall County.
Charles S. Davies, Junction City.
John Davies, Junction City.
H. H. Mead, Junction City.
James Hanway, Lane, Franklin County.
C. E. Abbe, Lawrence.
G. C. Brackett, Lawrence.
R. H. Fitts, Lawrence.
George F. Gaumer, Lawrence.
John Savage, Lawrence.
Prof. F. H. Snow, Lawrence.
J. H. Haldeman, Leavenworth.
William Carpenter, Leavenworth.
Ed. Russel, Leavenworth.
Dr. A. Axelson, Lindsborg.
J. B. Curtis, Lindsborg.
John A. Swenson, Lindsborg.
John Benjamin, Logan, Phillips County.
B. P. Hanan, Langdon, Reno County.
N. A. Adams, Manhattan.
John A. Anderson, Manhattan.
W. Dent, Manhattan.
Prof. E. Gale, Manhattan.
A. N. Godfrey, Manhattan.
Prof. W. K. Kedzie, Manhattan.
B. F. Mudge, Manhattan.
T. C. Wells, Manhattan.
J. S. Whitman, Manhattan.
L. R. Elliot, station agent, Manhattan.
Solomon Whitney, Manhattan.
A. R. Bardrick, Minneapolis, Ottawa.
L. W. Williston, Monument, Wallace County.
I. T. Goodnow, Neosho Falls.
M. S. Goss, Neosho Falls.
J. Rynearson, Newton.
F. L. Knott, Newton.
Thomas Beaumont, Norton, Norton County.
R. A. Case, North Lawrence.
W. E. McIntyre, Oakwood.
M. Mohler, Osborne City, Osborne County.
S. B. Abbott, Oswego, Labette County.
E. P. Diehl, Olathe.
Dr. A. H. Knapp, Osawatomie.
H. J. Smith, Ottawa.
E. Topping, Ottawa.
William Wheeler, Ottawa.
A. Willis, Ottawa.
C. O. Perkins, Oswego, Labette County.
A. Gridley, jr., Oxford.
Angell Mathews, Parsons.
A. M. Fellows, Parsons.
N. C. Rockhold, Parsons.
Dr. C. R. Lee, Pleasanton, Linn County.
Dr. H. A. Ellis, Russell.
C. D. Stevens, Raymond, Rice County.
H. L. Jones, Salina.
S. J. Gilmore, Salina.
A. G. Whitney, Salina.
S. M. Palmer, Salina.
H. Perley, Spring Hill, Johnson County.
Eugene Palmer, Tarland, McPherson.
F. G. Adams, Topeka.
J. W. Rogby, Tabor, Clay County.
W. Burlingame, Topeka.
G. P. Cooper, Topeka.
Alf. Gray, Topeka.
J. K. Hudson, Topeka.
G. W. Martin, Topeka.
C. D. Merrill, Topeka.
E. A. Papineau, Topeka.
S. S. Taylor, Topeka.
Dr. George Wyman, Topeka.
R. M. Spivey, Topeka.
A. S. Johnson, Topeka, land commissioner Atchison, Topeka and Santa Fé Railroad.
M. Wheeler, Twin Falls.
S. Hatch, Washena.
A. N. Moyer, Wyandotte.
W. W. Walton, Winfield.

MINNESOTA.

Abercrombie, John, Alexandria, Douglas County.
Abbott, E. E., Detroit, Becker County.
Acker, L. K., Alexandria, Douglas County.
Alden, C. H., Alexandria, Douglas County.
Andrews, B. C., Breckinridge, Wilkin County.
Andrews, J. Q., New London, Kandiyohi County.
Andrews, C. F., Centre Creek, Martin County.
Andrews, R., Wells, Faribault County.
Anderson, A. M., Montivideo, Chippewa County.
Arnold, J. T., Saint Peter, Nicollet County.
Barnes, G. S., Glyndon, Clay County.
Barnes, J. O., Saint Paul, Ramsey County.
Bailey, H., Elk River, Sherourne County.
Bates, Davies, Dewald, Nobles County.
Baltes, P. J., New Market, Scott County.
Barnum, E. P., Sauk Centre, Stearns County.
Barrows, C. A., Hersey, Nobles County.
Beatty, S. B., Dryden, Sibley County.
Beatty, Hon. H., Dryden, Sibley County.
Benton, R. C., Roseville, Kandiyohi County.
Blackwell, Henry, Holmes City, Douglas County.
Blair, Thomas, Delevan, Fairibault County.
Bost, T., Excelsior, Hennepin County.
Bottomly, James, Nashville Centre, Martin County.
Bonwell, A., Blue Earth City, Faribault County.
Brockway, H., Luverne, Rock County.
Brauner, J., sr., Sauk Rapids, Benton County.
Brawn, A. J., Watertown, Carver County.
Brakefield, J., Avon, Stearns County.
Bradford, M., Madelia, Watonwan County.
Bryan, J. G., Lake Benton, Lincoln County.
Bullard, C. H., Fairmount, Martin County.
Bullock, E. C., Oakland, Freeborn County.
Burt, T., Excelsior, Hennepin County.
Burt, S. V., New Auburn, Sibley County.
Burtman, J. P., Brush Prairie, McLeod County.
Burns, James, Berlin, Steele County.
Burchard, W., New Ulm, Nicollet County.
Buswell, G. W., Blue Earth City, Faribault County.
Callender, Hon. J. W., Jordan, Scott County.
Campbell, Daniel, Glenwood, Pope County.
Canfield, G. C., Collins, McLeod County.
Carpenter, Adna, Jonesville, Waseca County.
Chamberlain, G. C., Jackson, Jackson County.
Chapman, J. U., LeSueur, LeSueur County.
Chapman, C. H., Redwood Falls, Redwood County.
Churchill, Dr. D. B., Worthington, Nobles County.
Clarke, Ellis M., Murray Centre, Murray County.
Clevinger, S. S., New Auburn, Sibley County.
Clark, T. J., Cooleyville, Steele County.
Coe, Dr. S. B., Morristown, Rice County.
Cochrane, J. E., Chatham, Wright County.
Coffin, Samuel, Oshawa, Nicollet County.
Collins, H. B., Alden, Freeborn County.
Colbert, Patrick, Hancock, Carver County.
Cooley, J. B., Alexandria, Douglas County.
Colby, Mrs. L. H., Pelican Rapids, Ottertail County.
Copman, C. H., Redwood Falls, Redwood County.
Cowan, William, Minnetonka, Hennepin County.
Cowing, G. T., Fergus Falls, Otter Tail County.
Crandall, E., Sumter, McLeod County.
Crogan, Clement, Clitherall, Otter Tail County.
Cross, Stephen, Albert Lea, Freeborn County.
Cross, T. J., Shelbyville, Blue Earth County.
Cunningham, John, Hersey, Nobles County.
Curran, John, Darwin, Meeker County.
Davis, A. P., Marysburg, Blue Earth County.
Davis, D. P., South Bend, Blue Earth County.
Davies, John, Middletown, Jackson County.
Davis, H. H., Swansea, Renville County.
Day, C. K., Detroit, Becker County.
Deakin, Robert, Morris, Stevens County.
Denney, H. K., Carver, Carver County.
Devine, J. F., Madelia, Watonwan County.
Dickerson, Jacob, Lake Johanna, Pope County.
Donaldson, A. B., Alexandria, Douglas County.
Dow, C. W. W., Ransom, Nobles County.
Dunn, Jacob, San Francisco, Carver County.
Edwards, D. W., Heron Lake, Jackson County.
Edwards, William F., Silver Lake, Martin County.
Edwards, H. P., Easton, Faribault County.
Emery, B. C., Marshall, Lyon County.
Ewing, J. H., Ewington, Jackson County.
Fiddes, Alexander, Jackson, Jackson County.
Field, J. W., Marshfield, Lincoln County.
Fitzgerald, J., Osakis, Douglas County.
Flanders, Joseph, Madelia, Watonwan County.
Ford, S. E., Mountain Lake, Cottonwood County.
France, Joseph, Albert Lea, Freeborn County.
Freudenreich, George A., Alexandria, Douglas County.
Fost, E. S., Willmar, Kandiyohi County.
Frye, Daniel, Clear Lake, Sherburne County.
Fuller, J. F., Clearwater, Wright County.
Gardner, G. R., Grafton, Sibley County.
Gerdson, H., Chaska, Carver County.
Getty, J. J., Getty, Stearns County.

Gibbs, J. L., Genoa, Freeborn County.
Gilmore, H. D., Praha, LeSueur County.
Gilman, D., Watab, Benton County.
Gilman, C., Sauk Rapids, Benton County.
Gilman, H. D., Lanesburg, LeSueur County.
Gillam, S. S., Windom, Cottonwood County.
Gley, F. C., Springfield, Brown County.
Gowdby, L., Aurora, Steele County.
Goward, J., Freeborn, Freeborn County.
Greene, J. T., Little Rock, Nobles County.
Green, P. A., Langola, Benton County.
Green, J. J., Le Sueur, Le Sueur County.
Gregory, P. L., Saint Cloud, Stearns County.
Gretzwiller, J., jr., Delano, Wright County.
Hall, H. T., Clear Lake, Sherburne County.
Hall, M. O., Granite Falls, Yellow Medicine County.
Hall, D. A., Wood Lake, Yellow Medicine County.
Haly, John, Willmar, Kandiyohi County.
Hale, E. B., Vicksburg, Renville County.
Hand, A. C., Chain Lake Centre, Martin County.
Hanson, And., Emerald Lake, Faribault County.
Hart, G. W., Lake Lillian, Kandiyohi County.
Harriman, ——, Corinna, Wright County.
Hardy, William, Manannah, Meeker County.
Haskin, W. R., Walnut Lake, Faribault County.
Hawkins, L. B., Prior Lake, Scott County.
Henderson, J., Green Lake, Kandiyohi County.
Headly, J. J., Janesville, Waseca County.
Heath, Samuel D., Morris, Stevens County.
Herriot, W. B., Redwood Falls, Redwood County.
Higgins, H. H., Butterfield, Watonwan County.
Hodgson, H., Deerfield, Steele County.
Hogeson, T. E., Herman, Grant County.
Hofelt, Geo., Alma City, Waseca County.
Holly, H. W., Winnebago City, Faribault County.
Holton, Theodore, Lake Park, Becker County.
Hoffman, P., Otto, Pope County.
Horner, John, Granby, Nicollet County.
Howard, J. F., Albion, Wright County.
Howard, J. M., Litchfield, Meeker County.
Hughes, Thomas, Lake Prairie, Nicollet County.
Huntington, E. F., Glencoe, McLeod County.
Huntington, E. C., Windom, Cottonwood County.
Hurels, Henry, Shakopee, Scott County.
Irgens, H. M. F., Oscar Lake, Pope County.
Jacobson, J. P., Kerkhoven, Swift County.
Jewett, E. B., Marshal, Lyon County.
Johnson, A. M., Albert Lea, Freeborn County.
Jones, H. H., South Bend, Blue Earth County.
Jorgenson, Rev. L., Clark's Grove, Freeborn County.
Keesling, Benjamin, Wayzata, Hennepin County.
Kennedy, M. J., Winnebago City, Faribault County.
Kenehan, P., Wilton, Waseca County.
Kenney, Seth, Morristown, Rice County.
Kirk, J. C., Claska, Carver County.
Kimball, C. T., Cornish, Sibley County.
King, Mrs. J. M., Ben. Franklin, Murray County.
Knight, B. M., Walnut Station, Redwood County.
Koons, J., Glencoe, McLeod County.
Kyllander, Gustaf, West Newton, Nicollet County.
Lambert, Theodore, Saint James, Waseca County.
Larkin, J. S., Belleview, Blue Earth County.
Larson, Peter, New London, Kandiyohi County.
Lathrop, A. W., Appleton, Swift County.
Letford, J. S., Golden Gate, Brown County.
Lincoln, Oliver, Vienna, Rock County.
Lindburgh, August, Melrose, Stearns County.
Logan, T. J., Tyrone, Le Sueur County.
Luedloff, Charles, Dahlgren, Carver County.
Luce, A. J., Granite Falls, Yellow Medicine County.
Maxson, S. W., Dassel, Meeker County.
McCarty, Thomas, Saint Paul, Ramsey County.
Mayer, S. R., Montevideo, Chippewa County.
McDowell, N. V., Worthington, Nobles County.
McDermid, P. H., Nicollet Station, Nicollet County.
McDonald, J. N., Cosmos, Meeker County.
McGrew, J. G., Audubon, Becker County.
McKenzie, K., Glenwood, Pope County.
McCulloch, Sauk Rapids, Benton County.
McLelland, John, Detroit, Becker County.
McPadden, Stephen, Young America, Carver County.
Mead, J. M., Myrna, Blue Earth County.
Meehan, A., Blooming Prairie, Steele County.
Merrill, F., Lac-qui-parle, Lac-qui-parle County.
Mills, A. B., Mountain Lake, Cottonwood County.
Moberly, R. W., Adrian, Nobles County.
Moon, J. K., Saint Peter, Nicollet County.
Moore, J., Benson, Swift County.
Morse, John H., Deerfield, Steele County.
Murdy, P., Iosco, Waseca County.
Murphy, W. W., Madelia, Watonwan County.
Murray, P., Oakman, Waseca County.
Murray, A. K., Handen, Becker County.
Murray, Hugh, Lemond, Steele County.
Nixon, James, Dunbar, Faribault County.
Nobles, J., Glencoe, McLeod County.
Olson, Eric, Lake Belt, Martin County.
Palmer, C. L., Hawley, Clay County.

Palmer, Jared, Orr, Jackson County.
Parker, D. G., Albert Lea, Freeborn County.
Patterson, R., Benton, Carver County.
Patch, Henry, Courtland, Nicollet County.
Paulson, Edwin, Linden, Brown County.
Payne, Wm. O., Banks, Faribault County.
Payne, S. D., Kasota, Le Sueur County.
Pearsall, F. W., Lac-qui-parle, Lac-qui-parle County.
Phelps, Wm. T., Winona, Winona.
Pierce, Oliver, ——, McLeod County.
Pitman, J. M., Cedar Mills, Meeker County.
Plotts, Lieut. L. B., Worthington, Nobles County.
Pope, M. L., Cedarsville, Martin County.
Porter, Charles, Lamberton, Redwood County.
Porter, Charles E., ——, Renville County.
Potter, D. W., Windom, Cottonwood County.
Potter, M. C., Lyle, Mower County.
Post, T., Excelsior, Hennepin County.
Powers, G. M., Excelsior, Hennepin County.
Preston, L., Saint Olaf, Otter Tail County.
Probstfield, R. M., Glyndon, Clay County.
Raymond, L. B., Raymond, Stearns County.
Reynolds, Ira B., Eagle Lake, Blue Earth County.
Rhoda, Albert, Burnhamville, Todd County.
Rice, L. D., Albin, Brown County.
Rich, Mrs. S. C., Beaver Falls, Renville County.
Roan, T., Sauk Rapids, Benton County.
Roach, S. P., Paynesville, Stearns County.
Robbins, Hon. A. B., Willmar, Kandiyohi County.
Rogers, L. Z., Waterville, Le Sueur County.
Rollerson, O. J., Leinthrop, Chippewa County.
Rosser, Dr. J. C., Brainerd, Crow Wing County.
Russel, J., sr., Sauk Rapids, Benton County.
Salter, J. I., Saint Cloud, Stearns County.
Sandbury, N. T., Albert Lea, Freeborn County.
Sandford, H. F., Elbow Lake, Grant County.
Schneider, Rev. E. P., Millersville, Douglas County.
Scott, H. H., Round Prairie, Todd County.
Scoville, E. L., Meriden, Steele County.
Seeley, P. C., Clayton, Faribault County.
Shannon, C. E., Granite Falls, Yellow Medicine County.
Shaw, Col. S. D., Butternut Valley, Blue Earth County.
Sheiltis, Allen, Blue Earth City, Faribault County.
Siver, J. W., Paynesville, Kandiyohi County.
Simmons, H., Ft. Ridgely, Nicollet County.
Sloan, W. H., Hope, Watonwan County.
Smith, J. H., Montevideo, Chippewa County.
Smith, Wm., Meriden, Benton County.
Spencer, B. H., Sauk Rapids, Benton County.
Steadman, B. F., Medo, Blue Earth County.
Stiles, A. M., Ashley, Stearns County.
Streeseman, A. F., Transit, Sibley County.
Stutz, Joseph, West Newton, Nicollet County.
Sylvester, C. C., Madelia, Watonwan County.
Swan, J. B., Rapidan, Blue Earth County.
Sweet, Dr. E., Pipe Stone, Pipe Stone County.
TenEyck, Levi, Ceresco, Redwood County.
Terry, Alfred, Seward, Nobles County.
Thompson, J., New Richland, Waseca County.
Tiffany, A. W., Norwood, Carver County.
Tyler, C. B., New Ulm, Brown County.
Underwood, A. J., Fergus Falls, Ottertail County.
Urness, O. J., Moe, Douglas County.
Wade, Ed. F., Cedarville, Martin County.
Wagner, J. A., Becker, Sherburne County.
Walker, D., Sauk Rapids, Benton County.
Walker, G. B., Westbrook, Cottonwood County.
Walter, Clark, Sibley, Sibley County.
Warner, E. L., Rosewood, Chippewa County.
Ward, Hon. W. G., Waseca, Waseca County.
Webb, Wm., Sterling Center, Blue Earth County.
Webster, John, Norseland, Nicollet County.
Wellcome, Dr. J. H., Sleepy Eye, Brown County.
Werner, E. S., Montevideo, Chippewa County.
West, S. M., Warsaw, Rice County.
Weymouth, D. T., Marshall, Lyon County.
Weymouth, L. S., Greenleaf, Meeker County.
Whitman, Prof. Allen, Saint Paul, Ramsey County.
Whitcombe, G. F., Alexandria, Douglas County.
Whitney, L. A., Kandiyohi, Kandiyohi County.
Williams, C. A., Mapleton, Blue Earth County.
Williams, A. P., Silver Lake, McLeod County.
Wise, J. C., Mankato, Blue Earth County.
Wiseman, M., Sauk Rapids, Benton County.
Wood, M. L., Marshfield, Lincoln County.
Wood, G. E., Detroit, Becker County.
Woodbury, A., Rose Lake, Martin County.
Woodbury, C. E., Sibley, Sibley County.
Worden, Park, Minnesota Falls, Chippewa County.
Young, Samuel, Glenwood, Pope County.

MISSOURI.

E. D. Barton, Sarcoxie.
M. M. Tucker, Altona, Bates County.
J. T. Clark, Anson, Clark County.
James E. Gladish, Aullville, La Fayette County.
H. L. Hewitt, Austin, Cass County.

D. H. Webster, Austin, Cass County.
Dan Carpenter, Barry, Clay County.
William M. Hastings, Barry City, Saint Clair County.
J. S. Johnston, Golden City, Barton County.
J. C. McGeorge, Bethany, Harrison County.
John H. Crow, Bigelow, Holt County.
Samuel Miller, Bluffton.
J. Carson, Bolivar.
R. H. Talbot, Bolckow, Andrew County.
L. A. Brown, Boonsborough, Howard County.
Th. Kreglinger, Boyler's Mill, Morgan County.
M. S. Kellogg, Breckenridge.
Thomas Palmer, near Brunswick.
C. J. Ward, Bucklin, Linn County.
K. H. Burford, Burfordville, Cape Girardeau County.
H. Hilker, Bushberg.
G. E. Meissner, Bushberg.
M. W. Farris, Agency, Buchanan County.
E. P. Henry, Butler, Bates County.
J. Barlow, Cadet.
Jno. L. Rollins, Canton, Lewis County.
J. H. Burrows, Cainsville, Harrison County.
Jacobs & Marlow, Carthage, Jasper County.
E. J. Montague, Carthage, Jasper County.
S. D. McPherson, Carthage, Jasper County.
J. Tilden, Carthage, Jasper County.
C. A. Lacoste, Central P. O., Saint Louis County.
Dr. M. McKenzie, Centreville, Reynolds County.
F. Brewer, Chillicothe.
J. M. Gross, Chillicothe. (Box 250.)
W. H. Miller, Chillicothe.
B. P. Hanan, Clark City, Clark County.
William H. Fillery, Collins, Saint Clair County.
H. Krause, Concordia.
P. F. Pietz, Dutzow, Warren County.
J. J. Bryning, Doylesport, Barton County.
W. L. Snidow, Elkton, Hickory County.
J. F. Pores, M. D., East Lynne, Cass County.
Wm. A. Smith, East Lynne, Cass County.
C. J. Hostetter, East Lynne, Cass County.
Col. H. Fitch, Eagleville, Harrison County.
I. T. Moulton, jr., Farmington.
J. L. Motsinger, Fayetteville, Johnson County.
J. K. White, Flag Springs, Andrew County.
J. D. White, Forest City, Holt County.
G. W. Kinney, Foristell, Saint Charles County.
Wm. R. Howard, Forsyth, Taney County.
D. D. Martin, Freeman, Cass County.
T. J. Quick, Gaines, Henry County.
W. F. Tuttle, Golden, Barry County.
Hugh Stevenson, Gentryville, Gentry County.
C. L. Gould, Gould Farm, Caldwell County.
W. G. McDowell, Greenfield, Dade County.
R. A. Workman, Greenfield, Dade County.
F. Brooks, Greenwood.
L. P. Munzor, Hannibal.
H. Eshbough, Hanover, Jefferson County.
J. C. Evans, Harlem, Clay County.
James E. Payne, Harrisonville.
W. R. Meador, Hardin, Ray County.
R. B. Palmer, Hartsville.
G. E. Schultz, Havana, De Kalb County.
L. R. Rupard, Hazle Green, Laclede County.
W. S. Parish, Hickman Mills, Jackson County.
Ch. L. Carter, Holden, Johnson County.
W. A. Campbell, Holden, Johnson County.
T. D. Wallace, Hopkins, Nodaway County.
J. K. P. Idol, M. D., Houstonia, Pettis County.
Ch. Robords, Hudson, Bates County.
Levi Long, Island City, Gentry County.
A. Krekel, Jefferson City.
F. A. Nitchy, Jefferson City.
Ammon Ashford, Johnstown, Bates County.
Thos. B. Shrewsbury, Johnstown, Bates County.
W. T. Williams, Johnstown.
D. A. French, Kahoka, Clark County.
Frank Riblet, Kahoka, Clark County.
C. H. Allen, Kansas City.
Theo. S. Case, Kansas City.
D. L. Hall, Kansas City.
Jno. B. Wornall, Kansas City.
Frank Holsinger, Kansas City.
R. H. Stone, Kansas City.
H. A. White, Kansas City.
E. W. Whitmore, Kansas City. (Box 1144.)
J. B. Reavis, Kingsville, Johnson County.
J. C. Dooley, Kirksville.
A. A. Dye, Lamar, Barton County.
Robt. Watson, Lee's Summit.
Wm. H. Avery, Lamar, Barton County.
J. E. Stringer, Leesville, Henry County.
J. Belt, Lexington, La Fayette County.
W. B. Krimminger, Le Roy, Barton County.
M. L. Modrel, Little Osage, Vernon County.
J. T. Ferguson, Snibar, La Fayette County.
Wm. H. Clark, Luteston, Nodaway County.
Wm. Stark, Louisiana.
J. F. Brickell, Macon.
F. W. Gaunt, Maryville, Nodaway County.
Fred. Hastings, Maryville, Nodaway County.
A. H. Smith, Memphis.
A. Troth, Memphis.
Wm. H Barton, Mexico.
W. G. Church, Mexico.
P. E. Locke, Mexico.
L. D. Shippee, Mexico.
Sam. McCray, Mitchellville, Harrison County.
R. M. Walker, Monroe City.
H. C. Pritchett, Morrisville, Polk County.
J. M. Loafman, M. D., Morrisville, Polk County.
G. B. Hickman, Mulberry, Bates County.
Jno. Cecil, Mount Vernon.
C. S. Whitescarver, Mount Pleasant, Gentry County.
J. H. Maxwell, Mount View, Benton County.
W. S. Goodman, Mount Vernon, Lawrence County.

H. Jaeger, Neosho, Newton County.
G. C. Broadhead, Neosho, Newton County.
Norman Gibbs, Mount Vernon.
Jno. Thrasher, Neosho, Newton County.
Jno. Snevely, Neosho, Newton County. (P. O. box 126.)
H. Shepley, Nevada, Vernon County.
J. Whiteley, New Castle, Gentry County.
A. Irvine, Oregon, Holt County.
J. W. Maple, Oregon, Holt County.
Wm. Kaucher, Oregon, Holt County.
Bennett King, Oregon, Holt County.
T. W. Simpson, Payne's Prairie, Polk County.
T. W. Wilson, Payne's Prairie, Polk County.
P. O. Connor, M. D., Peculiar, Cass County.
D. M. Proctor, Philadelphia.
T. J. West, Phelps City.
M. T. Rowe, Pink Hill, Jackson County.
M. B. W. Harman, Pickering, Nodaway County.
Jos. Adkins, Platte City, Platte County.
R. P. C. Wilson, Platte City, Platte County.
A. J. McCraynor, Plattsburg.
Jas. H. Birch, Plattsburg.
J. H. Broadhead, Pleasant Hill.
C. C. Thomas, Point Pleasant, New Madrid County.
B. V. Braddus, Princeton.
W. H. Barron, Raymore, Cass County.
David Defakaugh, Raymore, Cass County.
J. M. Thornburg, Reeds, Jasper County.
Jno. H. Dopf, Rockport, Atchison County.
J. Kimbertin, Rochester, Andrew County.
C. E. Treadwell, Rockport, Atchison County.
O. Root, jr., Salisbury, Chariton County.
H. Baltegor, Saint Charles.
Kelsey & Co., Saint Joseph.
P. B. Sibley, Saint Joseph.
J. P. Singleton, Saint Joseph.
L. J. Winton, Saint Joseph.
Thos. McNallie, Sarcoxie, Jasper County.
E. D. Barton, Sarcoxie, Jasper County.
Wm. Challacombe, Savannah, Andrew County.
L. N. Guild, Sedalia, Pettis County.
G. Husmann, Sedalia, Pettis County.
O. A. Crandall, Sedalia, Pettis County.
W. H. Wetherell, Seneca, Newton County.
W. G. L. Craig, Smithfield, Jasper County.
D. S. Holman, Springfield, Greene County.
F. H. Sheppard, Springfield, Greene County.
F. F. Fine, Springfield, Greene County.
A. J. Culbertson, Stewartsville, DeKalb County.
John T. Pickett, Stewartsville, DeKalb County.
J. W. Montgomery, Stockton, Cedar County.
W. Smiley, Stockton, Cedar County.
J. T. Ferguson, Sinibar, Lafayette County.
Jacob Gregg, Stony Point, Jackson County.
John Hill, Taborville, Saint Clair County.
Wm. Hall, Walker, Vernon County.
J. Q. Thomson, Vernon County.
W. L. Lemmon, Warrensburg, Johnson County.
Prof. Straight, Warrensburg, Johnson County.
J. L. Cleland, Warrensburg, Johnson County.
R. T. Sill, Warsaw, Benton County.
James H. Lay, Warsaw, Benton County.
W. V. L. McClellan, Wellington, La Fayette County.
R. T. Ellifrit, Weston.
C. W. Jordan, Whitehare, Cedar County.
R. J. Lewis, Westport.
J. F. Smith, Whitesville, Andrew County.
H. G. Quincy, Wright City, Warren County.
R. W. King, Young's Creek P. O., Andrew County.

MONTANA.

Frank P. Davis, Bannock, Beaver Head County.
J. V. Bogert, Bozeman, Gallatin County.
W. Clark, Bozeman, Gallatin County.
James Gomley, Bozeman, Gallatin County.
John Johnson, Bozeman, Gallatin County.
B. Klein, Bozeman, Gallatin County.
P. W. Macadow, Bozeman, Gallatin County.
Dr. Lamme, Bozeman, Gallatin County.
J. D. McCammon, Bozeman, Gallatin County.
George McCullum, Bozeman, Gallatin County.
Mr. Malin, Bozeman, Gallatin County.
Thomas Shirley, Bozeman, Gallatin County.
Gen. Lester Wilson, Bozeman, Gallatin County.
Wm. E. Tierney, Canton, Meagher County.
Phil. E. Evans, Deer Lodge, Deer Lodge County.
Henry B. Hoffman, Deer Lodge, Deer Lodge County.
Conrad Kohrs, Deer Lodge, Deer Lodge County.
C. H. Manning, Deer Lodge, Deer Lodge County.
John S. Pemberton, Deer Lodge, Deer Lodge County.
R. N. Sutherlin, Diamond City, Meagher County.
James M. Arnoux, Fort Benton, Choteau County,
J. J. Donnelly, Fort Benton, Choteau county.
Robert A. Miller, Fort Benton, Choteau County.
O. O. Mortson, Ft. Benton, Choteau County.
S. S. Turner, U. S. A., Fort Peck.
Lieut. C. A. Booth, Fort Shaw, Lewis and Clarke County.
Genl. Jno. Gibbon, U. S. A., Fort Shaw, Lewis and Clarke County.

Morgan Evans, Givendale, Deer Lodge County.
Henry Hebe, Hamilton, Gallatin County.
John Potter, Hamilton, Gallatin County.
Phillip Thorpe, Hamilton, Gallatin County.
James Fergus, Helena, Lewis and Clarke County.
T. P. Tuller, Helena, Lewis and Clarke County.
W. C. Gillette, Helena, Lewis and Clarke County.
M. C. Hedges, Helena, Lewis and Clarke County.
M. Hilger, Helena, Lewis and Clarke County.
J. C. Kelsey, Helena, Lewis and Clarke County.
J. B. Porter, Helena, Lewis and Clarke County.
Governor Potts, Helena, Lewis and Clarke County.
Thomas Reice, Helena, Lewis and Clarke County.
James McCartney, Mammoth Hot Springs.
Chauncey Barbour, Missoula, Missoula County.
P. B. Clark, Radersburg, Jefferson County.
R. P. Bateman, Sheridan, Madison County.
S. Hall, Sheridan, Madison County.
J. W. Hyde, Sterling, Madison County.
R. M. Goin, Sterling, Madison County.
P. V. Jackson, Sterling, Madison County.
R. S. Ford, Sun River Crossing, Lewis and Clarke County.
John Healy, Sun River Crossing, Lewis and Clarke County.
George Steele, Sun River Crossing, Lewis and Clarke County.
J. H. Baker, Virginia City, Madison County.
T. T. Baker, Virginia City, Madison County.
Judge H. R. Blake, Virginia City, Madison County.
A. B. Knight, Virginia City, Madison County.
James Maynard, Virginia City, Madison County.
R. R. Watkins, Virginia City, Madison County.

NEBRASKA.

Abbott, C. S., Pleasant Hill, Saline County.
Aughey, Prof. Samuel, Lincoln, Lancaster County.
Babbitt, T. N., Sunlight, Cass County.
Bailey, B. H., Bratton, Nemaha County.
Blanchard, G. T., Tremont, Dodge County.
Child, A. L., Plattsmouth, Cass County.
Clarke, Loran, Albion, Boone County.
Cox, H. M., Chapman, Merrick County.
Davidson, J. H., Burr Oak, Otoe County.
Dodge, G. M., Glencoe, Dodge County.
Eisley, C. T., Hooper, Dodge County.
Elliot, W. W., Pleasant Home, Polk County.
Fitzpatrick, J. W., Hebron, Thayer County.
Gantt, D. T., Steele City, Jefferson County.
Gerdes, William, Arayo, Richardson County.
Graff, Lewis A., Kearney, Kearney County.
Hendricks, H. O., Amazon, Franklin County.
Holmes, C. A., Tecumseh, Johnson County.
Hulliban, T. G., Niobrara, Knox County.
Hutchings, George, Falls City, Richardson County.
Kennedy, H., Omaha, Douglas County.
LaMunyon, I. W., North Platte, Lincoln County.
Mills, B. D., Republican City, Harlan County.
Norton, Sterling J., Nebraska City, Otoe County.
Reavis, Isham, Falls City, Richardson County.
Rockwell, James, Ponca, Dixon County.
Smith, C. C., Falls City, Richardson County.
St. Clair, W. P. P., Ogalalla, Keith County.
Stolley, William, Grand Island, Hall County.
Touzaline, A. E., Lincoln, Lancaster County.
Truman, G. S., Genoa, Platte County.
Vosburg, J., Farmers' Valley, Hamilton County.
Wells and Neiman, Schuyler, Colfax County.
Wise, John, Nebo, Platte County.
Wheeler, D. H., Plattsmouth, Cass County.
Whitcomb, E., Friend, Saline County.

NEVADA.

Ralston Brothers, Bull Run Creek.
William H. Snyder, Cornucopia, Elko County.
C. C. Wheeler, Cornucopia, Elko County.
Isaac V. Button, Little Humboldt Valley.
Merritt Carroll, Paradise Valley, Humboldt County.
S. C. Carroll, Paradise Valley, Humboldt County.
Ritchie & Brauner, Paradise Valley, Humboldt County.
C. C. Pope, Reno, Washoe County.
I. Daniel Bonelli, Saint Thomas, Lincoln County.
William Aiken, Sweet Water, Esmeralda County.
Edward Ham, White Rock, Elko County.
Painter & Stoff, White Rock, Elko County.

NEW MEXICO.

George May, Socorro.
Alexander Gusdorf, Ranchos de Taos.

OREGON.

R. W. Gwinn, Baker City, Baker County.
Henry Heisy, Clarksville, Baker County.
Frank Laugherty, Clarksville, Baker County.
Dr. Rafferty, East Portland, Multnomah County.
George Benton, Portland, Multnomah County.
C. Roop, Portland, Multnomah County.
J. R. Foster & Co., Umatilla, Umatilla County.
J. H. Kenzie, Umatilla, Umatilla County.

TEXAS.

D. A. Todd, Austin.
W. C. Walsh, Austin.
Hon. J. Hancock, M. C., Austin.
J. H. Shaw, Austin.
V. O. King, Austin.
J. H. Secrist, Austin.
Governor Richard Coke, Austin.
J. W. Miller, Bastrop.
J. S. Moores, Bastrop.
William H. Thacker, Brenham.
W. L. Coleman, Calvert.
T. J. Moulton, jr., Calvert.
D. N. Dodson, Cambridge.
G. W. Belfrage, Clifton, Bosque County.
O'Niel McKechnie, Clifton, Bosque County.
Hon. R. Q. Mills, M. C., Corsicana.
J. H. Stevens, Dallas.
A. J. Ross, Dallas.
H. J. Coe, Dallas.
J. C. M. Crockett, Dallas.
J. Boll, Dallas.
A. W. Acheson, 225 West Main street, Denison.
T. V. Munson, Denison.
Wenk Brothers, Galveston.
Nelson & Sadler, Galveston.
W. D. Donaldson, Headsville.
H. Brous, Helores.
A. B. Small, Houston.
C. P. B. Martin, Huntsville.
A. H. R. Bryant, Pilot Point, Denton County.
D. Donavan, Maysfield, Milam County.
C. S. Taleatero, Navasota.
J. C. Melcher, O'Quin, Black Jack Springs.
H. C. Overaker, Plano, Collin County.
J. H. Myers, Salado, Bell County.

UTAH.

H. D. Pickman, Diamond City, Juab County.
Horton & Haight, Farmington, Davis County.
William V. Haight, Farmington, Davis County.
John Bartholomew, Fayette, San Pete County.
William Jeffries, Grantsville, Tooele County.
G. H. Crossly, Hebron, Washington County.
Charles Shelton, Helen City, Wasatch County.
W. D. Johnson, jr., Kanab, Kane County.
Henry Ballard, Logan, Cache County.
William B. Preston, Logan, Cache County.
Supt. Thacher, Logan, Cache County.
John Vickers, Nephi City, Juab County.
F. A. Brown, Ogden, Weber County.
John I. Hart, Ogden, Weber County.
John Spiers, Ogden, Weber County.
Isaiah M. Combs, Payson, Utah County.
Andrew L. Siler, Ranch, Kane County.
Joseph L. Barfoot, Salt Lake City, Salt Lake County,
John Readings, Salt Lake City, Salt Lake County.
Serg. W. McGillivray, Salt Lake City, Salt Lake County.
Col. A. P. Rockwood, Salt Lake City, Salt Lake County.
Brigham Young, Salt Lake City, Salt Lake County.
E. C. Johnson, Silver Reef, Washington County.
Francis Sharpe, Smithfield, Cache County.
George D. Snell, Spanish Fork City, Utah County.
B. F. Johnson, Spring Lake, Utah County.
Joseph E. Johnson, Saint George, Washington County.
Edward Palmer, Saint George, Washington County.
George W. Burridge, Saint John's, Tooele County.
Joseph J. Bishop, Adamsville, Beaver County.
Daniel Tyler, Beaver City, Beaver County.
Benjamin F. Johnson, Benjamin, Beaver County.
John Chatter'y, Cedar City, Iron County.
Rev. G. Charles Buntine, Croydon, Morgan County.

WASHINGTON TERRITORY.

J. H. Wilbur, Fort Simcoe, Yakima County.
Rev. Luther Wilbur, Fort Simcoe, Yakima County.
D. N. Utter, Olympia, Thurston County.
J. G. Swan, Port Townsend, Jefferson County.
J. K. Lum, Skookumchuck, Lewis County.
W. B. Blackwell, Tacoma, Pierce County.
W. Byron Daniels, Vancouver, Clark County.
D. S. Baker, Walla Walla, Walla Walla County.
Charles Bessemer, Walla Walla, Walla Walla County.
W. L. Gwinn, Walla Walla, Walla Walla County.
Phillip Ritz, Walla Walla, Walla Walla County.

WYOMING.

Capt. W. S. Collier, Camp at Red Cañon.
J. K. Moore, Camp Brown, Sweet Water County.
A. P. Frick, Camp on Hot Creek.
E. P. Snow, Cheyenne, Laramie County.
William E. Carlin, Como Station.
Captain Coates, Fort Fetterman, Albany County.
Maj. A. W. Evans, Fort Laramie, Laramie County.
P. P. Dickenson, Lander, Sweet Water County.
T. A. Maccory, Sandy Station.

APPENDIX XXVII.

BIBLIOGRAPHY ON THE LOCUSTS OF AMERICA.

[At the request of the Commission, Mr. B. Pickman Mann, of Cambridge, Mass., has been kind enough to prepare a bibliography of locust literature for all countries. We are, unfortunately, obliged to omit that part pertaining to other countries than America, for the reasons stated in the Preface, and for the further reason that the Government Printing Office has no Russian type. The bulk of it will, however, be found in Hagen's "Bibliotheca entomologica" and in Köppen's "Ueber die Heuschrecken in Südrussland". Those references preceded by an asterisk (*) have been verified by Mr. Mann; those with a dagger (†), by Dr. Hagen.]

NORTH AMERICAN LOCUSTS.

*Asa Fitch, M. D. Reports on the noxious and other insects of New York. < Transactions of the N. Y. State Agricultural Society. Albany.
Third Report. 1856. p. 315–490 + 2 pl. fig.

p. 487–490 + 2 pl. Notice of the gigantic locusts of tropical America, *Acrydium cristatum*, *A. dux*, *A. latreillei*, and *A. semirubrum*.

*†Alex. S. Taylor. An account of the grasshoppers and locusts of America. < Annual Report of the Smithsonian Institution for 1858. 1859. p. 200–213.

[Hagen, II, 394.] Accounts mainly collated, of locust invasions in the Pacific United States, in Mexico, and in Central America.

*B. Dann Walsh. Grasshoppers and locusts. < Practical Entomologist. 1866. v. 2, p. 1–5, p. 22.

First specifically recognizable mention of *Caloptenus spretus*; its correct name; its ravages and migrations; probable limits of its range; means of preventing its increase.

*B. Dann Walsh *and* C: V. Riley. Grasshoppers. < American Entomologist. 1868. v. 1, p. 16.

Occurrence of *Caloptenus femur-rubrum*, *C. differentialis*, *C. bivittatus*, and *Œdipoda carolina* in Illinois; their ravages in Iowa.

*M. C. Nickerson. "Grasshoppers." Their devastations in western Iowa and the good that has resulted from them. < American Entomologist. 1868. v. 1, p. 27–28.

Seasons and ravages of *Caloptenus spretus* in Iowa; importation by them of the seeds of *Vilfa vaginæflora*.

*B. D. Walsh. First annual report on the noxious insects of the state of Illinois. From the Appendix to the Transactions of the Illinois State Horticultural Society. Chicago, 1868. 103 p. + 1 pl.

p. 82–103. Insects infesting garden-crops generally. Chapter XIV.—The hateful grasshopper, (Caloptenus spretus, Walsh.)

Eastern limit of the range of the locust; occurrence and ravages of the locust in Texas and Missouri in 1866, and in the Mississippi Valley in 1867; its various irruptions in bygone years, east and west of the Rocky Mountains; distinction between it and *Caloptenus femur-rubrum*.

*B. D. Walsh *and* C: V. Riley. Grasshoppers. < American Entomologist. 1868. v. 1, p. 53.

Caloptenus femur-rubrum, *C. differentialis*, *C. bivittatus*, *Œdipoda carolina*, and *Acheta abbreviata* have been unusually abundant this year in Kentucky and in most of the northwestern states east of the Mississippi river; at the same time, the locusts have been very scarce in New York.

*B. D. Walsh *and* C: V. Riley. The hateful or Colorado grasshopper. (Caloptenus spretus, Uhler and Walsh.) < American Entomologist. 1868. v. 1, p. 73–76, fig. 65.

Caloptenus spretus distinguished from *C. femur-rubrum*; native haunts, migrations, geographical range and ravages of the former.

*W: N. Byers. The "Colorado grasshopper". < American Entomologist. 1869. v. 1, p. 94–95.

Native haunts, migrations, ravages, and enemies of the locust.

*D. A. A. Nicholls. Grasshoppers in the state of New York. < American Entomologist. 1868. v. 1, p. 96.

Opposes the statement on p. 53 of this journal that locusts were scarce in New York in 1868, at least for the extreme western part of the state; what plants were destroyed by the locusts.

*V. Devinny. The "Colorado grasshopper". < American Entomologist. 1869. v. 1, p. 95.

Objects to the name as casting odium on Colorado, whereas it is equally numerous and native in other regions; the habits of the native "spring grasshopper" are different from those of the immigrating "fall grasshopper"; effect of weather on the hatching of eggs.

*James H. Parsons. Grasshoppers. < American Entomologist. 1869. v. 2, p. 52.

Scarcity of locusts in Franklin, N. Y., in 1869.

*Cyrus Thomas. The hateful, or Colorado grasshopper.—(Caloptenus spretus, Uhler and Walsh.) < American Entomologist. 1870. v. 2, p. 81–84.

A summary of investigations during a trip through Colorado and New Mexico. Seasons, native haunts, migrations, and localities of occurrence of locusts.

*S. S. Rathvon. Rocky Mountain grasshopper cannot live in Pennsylvania. < American Entomologist. 1870. v. 2, p. 88.

Young locusts, accidentally introduced into Lancaster, Pa., all perished.

*F. V. Hayden. Reports of the United States Geological Survey of the Territories. Washington, [1867–]1872–1877. Reports 1–9.

Fourth Report. 1872. p. 249–261. S. H. Scudder. Notes on the Orthoptera collected by Dr. F. V. Hayden in Nebraska.

List of species observed in Nebraska. Remarks on the devastating grasshoppers of North America, *Caloptenus femur-rubrum*, *C. spretus*, *Œdipoda atrox* n. sp.; ravages of *C. femur-rubrum* in New England; notes upon *C. spretus*, as observed during its invasion of western Iowa in August and September, 1867; ravages of *Œ. atrox* on the Pacific coast.

Fifth Report. 1872. p. 423–466 + 2 pl. Cyrus Thomas. Notes on the saltatorial Orthoptera of the Rocky Mountain regions.

Sources of information; systematic arrangement of families of Orthoptera; distribution of species between the eastern, middle, and western districts of the United States west of Missouri; list of species, with descriptions of new species; p. 445–466, Acrididæ.

Sixth Report. 1873. p. 719–725. Cyrus Thomas. Notes on Orthoptera.

General remarks on geographical distribution and on descriptive characters of the species.

Ninth Report. 1877. p. 589–809 + 9 pl. (pl. 62–70) + 5 maps 23×27; 67 fig. A. S. Packard, Jr., M. D. Report on the Rocky Mountain locust and other insects now injuring or likely to injure field and garden crops in the western states and territories.

Locusts, p. 591–693; their occurrence and ravages in Colorado, Kansas, Wyoming, Utah New Mexico, and Nevada; their northern range; their invasion of Texas, Kansas, Iowa, Minnesota, Nebraska, Dakota, Montana, Colorado, Wyoming, Utah, and New Mexico in 1876; their habits, seasons, development, classificatory characters, geographical distribution, and migrations; the migratory locusts of Central and South America and those of Europe, Asia, and Africa; external enemies and parasites of the *Caloptenus spretus*; measures for preventing the ravages of the locusts; summary of our present knowledge of the locust; inquiries to which answers are needed; meteorological data on the mean temperature, mean relative humidity, prevailing wind, and total movement in the various months of the years 1871–1876 at numerous stations in the western United States; breeding habits of *Caloptenus femur-rubrum*; ravages and migrations of the latter species in the eastern United States; ravages of *Œdipoda pellucida* in California, and description of the imago; ravages of *Acrydium americanum* in the southeastern United States; ravages of *Anabrus simplex* and *A. haldemani* in Utah and neighboring regions; descriptions of the last two species.

*Cyrus Thomas. Synopsis of the Acrididæ of North America. Report of the United States Geological Survey of the Territories. Vol. 1, pt. 1. Washington, 1873. 10 + 262 p. + 1 pl.

*S. E. Wilber. Animal migrations. < Popular Science Monthly. 1874. v. 4, p. 745–746.

——— [Same?] < *New England Farmer. 1875. v. 53, no. 29.

The attacks of dipterous parasites the sole incentive to the migrations of locusts.

*Anonym. Grasshoppers in Minnesota. [From (Chicago) Inter-Ocean.] < New York Commercial Advertiser, June 1, 1874.

Habitats, habits, and enemies of locusts.

*Anonym. Grasshoppers stopping cars. [From St. Joseph (Mo.) Herald.] < Hartford Daily Courant, v. 38, no. 198 (11,163), Aug. 19, 1874.

Stoppage of railroad trains by locusts.

*Anonym. The locust in Minnesota. < Scientific American. 1874. v. 31, p. 65.

Description and habits of *Caloptenus spretus*; extent of its ravages; means against locust in Europe and Africa; their natural enemies.

*Anonym. The western locust plague. < Scientific American. 1874. v. 31, p. 119, fig

Habits of *Caloptenus spretus*; damage done by locusts in Minnesota, and means against them.

*J. Whiteford. The plague of locusts. < Scientific American. 1874. v. 31, p. 196.

Means against and natural enemies of locusts.

*C: R. Dodge. The "lubber" grasshopper. < Rural Carolinian. 1874. v. 5, p. 363.

Habits of and means against *Rhomalea microptera*.

*Léon Provancher. Les sauterelles. < Naturaliste Canadien. 1874. v. 6, p. 270.

Excellence of locusts as human food.

*Dr. H. Weyenbergh. Mangas de langostas (Acridium paranense Burm.) en la República Argentina durante 1873. < Periódico Zoológico. 1874. v. 1, p. 33–43.

Chronological summary of earlier observations; directions and times of flights; size of swarms.

*W. L. Carpenter. Artificial hatching of grasshoppers. < American Naturalist. 1875. v. 9, p. 312.

Locusts hatched in January in Dakota by the heat of camp-fires. Doubts (by the editors) whether the hatching had not taken place in the previous autumn.

*C: V. Riley. Annual reports on the noxious, beneficial and other insects of Missouri, made to the State Board of Agriculture. Jefferson City, Mo.

*Seventh Report. 1875. 196 + 4 p. 39 fig.

p. 121–196, fig. 23–39. The Rocky Mountain locust—*Caloptenus spretus* Thomas; its characters; its natural and chronological history, habits, ravages, enemies and parasites, home, migrations and geographical distribution; means of preventing its ravages.

*Eighth Report. 1876. 185 + 4 p. 55 fig.

p. 57–156, fig. 39–47. The Rocky Mountain locust—*Caloptenus spretus* Thomas; detailed account of its ravages in Missouri and neighboring states in 1875; natural history of the young; definition of the species; its native home, migrations, and ravages; changes that follow the ravages; natural and artificial means of repressing the locusts; use of the locusts as food.

*Ninth Report. 1877. 129 + 3 + 1 pl. (fig. 16), 32 fig.

p. 57–124, fig. 16–29. The Rocky Mountain locust—*Caloptenus spretus* Thomas; its doings in 1876 in the northern and eastern states west of the Mississippi river; detailed reports from counties in Missouri; source, direction, rate, and extent of its flights; its geographical range and that of its allies; its manner of egg-laying and of hatching; new enemies and parasites; experiments to determine the best artificial means of reducing its ravages; laws passed by Missouri, Kansas, and Minnesota providing for the destruction of the locusts; prospects of locust invasions in 1877.

*Frank H. Snow. The Rocky Mountain locust. (Caloptenus spretus Uhler.) < Transactions of the Kansas Academy of Science. 1875. v. 4, p. 26–28.

Seasons, ravages, abundance, direction of flight, and natural enemies of the locusts.

*E. F. Jackson. Grasshoppers again troublesome in Minnesota. < Field and Forest. 1875. v. 1, p. 31.

Occurrence of locusts in Minnesota in 1875; they and their eggs destroyed by parasites.

*E. C. Huntington. Grasshoppers again troublesome in Minnesota. < Field and Forest. 1875. v. 1, p. 31.

Incursion of locusts in Minnesota in 1875; their eggs laid abundantly.

*Jos: Willcox. On the flight of grasshoppers. < Proceedings of the Academy of Natural Sciences of Philadelphia. 1875. p. 361.

Locusts were observed repeatedly in Colorado to descend to the ground before each shower of rain, taking flight again after the shower.

*C: J. S. Bethune. Grasshoppers or locusts. < Annual Report of the Entomological Society of Ontario, for 1874. 1875. p. 29–42, fig. 30–34.

Confusion in the names locust and grasshopper; figures of *Cicada septendecim*, *Œdipoda migratoria*, *Cyrtophyllum concavum*. History of visitations of locusts in earlier times in America, and of the plague of locusts in 1874, especially in Nebraska, Minnesota, Kansas, and Manitoba. Description and figures of *Caloptenus spretus* and *C. femur-rubrum*. Means of reducing the ravages of the locusts.

*S: H. Scudder. Habits and forms of Caloptenus spretus. < Psyche. 1876. v. 1, p. 144.

Doubts whether the destructive swarms of locusts start from the heart of the Rocky Mountains; *C. atlanis* perhaps a geographical race of *C. spretus*.

*C: J. S. Bethune. The western locusts. < Annual Report of the Entomological Society of Ontario, for 1875. 1876. p. 45–54, fig.

Compilation, from various sources, of reports upon the occurrence and doings of *Caloptenus spretus* in 1875 in Manitoba and in the United States west of the Mississippi river; extract, from Riley's eighth report, of suggestions of means of reducing the ravages of the locusts; locusts as an article of food.

George M. Dawson. Notes on the locust. Invasion of 1874 in Manitoba and the north west territories. 16 p. 8°.

[From the Canadian Naturalist.]
List of invasions of Manitoba by *Caloptenus spretus*. Directions in which the locusts travel. Coniferous forests seem to cut off their migrations. Least endangered crops. Special reports from numerous observers at distant stations.

*Geo. M. Dawson. Notes on the appearance and migrations of the locust in Manitoba and the north west territories—Summer of 1875. 20 p. 8°.

[From the Canadian Naturalist.]
[Subject expressed by title.]

Geo. M. Dawson. Notes on the appearance of the locust in Manitoba and the northwest territories. Summer of 1876. May, 1878. p. 8°.

[From the Canadian Naturalist.]

*J. B. Phillips. The Rocky Mountain locust. Caloptenus spretus. Statistics of Minnesota for 1876. Being the Eighth Annual Report of the Commissioner of Statistics, p. 88–112.

On the wide distribution of destructive locusts. Accounts of the flight of *Œdipoda migratoria* far out on the Atlantic ocean and into Europe. Particulars of the European invasion of 1747 and 1748, and accounts of other invasions of *Œ. migratoria*. Statistics of all the invasions of destructive locusts within the United States since 1818. Tables showing the damage done by locusts in Minnesota in 1875.

*J: C. Wise, Warren Smith, *and* Allen Whitman. The grasshopper, or Rocky Mountain locust, and its ravages in Minnesota.—A special report to the Hon. C. K. Davis, Governor of Minnesota.—Five thousand copies ordered printed.—Saint Paul, Pioneer Press Company, 1876. 50 p. 8°. 8 fig.

List of writings and other sources of information; record of invasions of *Caloptenus spretus* since 1819, and particularly of invasions of Minnesota; years, seasons, and places of invasion and departure; ravages; characteristics, relationships, and descriptions (with figures) of *C. spretus, C. femur-rubrum, C. differentialis, C. bivittatus, C. atlanis;* growth, habits, native breeding-grounds, oviposition, and food of *C. spretus;* natural and artificial means of destruction of the locusts; climatic influences; enemies; parasites.

*J: S. Pillsbury, C: V. Riley, *and* Pennock Pusey. The Rocky Mountain locust, or grasshopper, being the report of proceedings of a conference of the governors of several western states and territories, together with several other gentlemen, held at Omaha, Nebraska, on the 25th and 26th days of October, 1876, to consider the locust problem; also a summary of the best means now known for counteracting the evil. Saint Louis, 1876. [4] + 58 + p. 23+15. 8 fig.

Proceedings; practical considerations and suggestions for the repression of *Caloptenus spretus;* description, oviposition, transformations, and habits of the locust; its enemies and parasites; means against it in its various stages.

*C: V. Riley. Locusts as food for man. < Proceedings of the American Association for the Advancement of Science. Salem, 1876. v. 24, pt. 2, p. 208–214.

Use of locusts as food in different ages and countries; how they are cooked; what kinds are eaten.

*C: V. Riley. The locust plague; how to avert it. < Proceedings of the American Association for the Advancement of Science. 1876. v. 24, pt. 2, p. 215–222.

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*W. R. Gerard. Insects as articles of food. < Proceedings of the Poughkeepsie Society of Natural Science. 1876. v. 1, p. 17–31.

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*Alfred Gray. The Rocky Mountain locust in Kansas, in 1877. < Monthly Reports of the Kansas State Board of Agriculture for August, September and October, 1877. 1877. p. 21–42, fig. 1–3.

p. 21–25. Report by Geo. P. Gaumer.

Times of appearance of young locusts; hatching of eggs; enemies of the locusts.

p. 25–31, fig. 1–3. Report by A. N. Godfrey.

Deposition of eggs; egg-parasites; times of hatching; measures and tools for the destruction of locusts; natural enemies; direction of flights.

p. 32–41. Address by Prof. C. V. Riley. Locusts—their origin, migrations, and limits.—Two successive hatchings, in same region, improbable.

Name; geographical range; native haunts; susceptibility of control; migrations; avoidance of regions infested in the previous year; egg-parasites; summary of statistics of flights in 1877; final destination.

p. 42. G. H. Gaumer. Confounding species.

Synoptic table distinguishing *Caloptenus femur-rubrum*, *C. spretus*, and *C. atlanis* from each other.

*C: V. Riley. The locust plague in the United States: being more particularly a treatise on the Rocky Mountain locust or so-called grasshopper, as it occurs east of the Rocky Mountains, with practical recommendations for its destruction. Chicago, Rand, McNally & Co. 1877. 236 p. + 3 pl. 8°. 42 fig.

Characters of the species; differences and resemblances between *Caloptenus spretus*, *C. femur-rubrum* and *C. atlanis:* comparisons of the three in early stages; chronological history of locust invasions; detailed account of invasions from 1873–1876; eastern limit reached; native home and geographical range; source of disastrous swarms; causes of migration; natural history and transformations; philosophy of the egg-mass, hatching process; habits and power for injury; direction and destinat on of departing swarms; effects of young insects in country where they hatch, but where they are not indigenous; changes that follow the locusts; natural enemies; practical considerations; destruction of eggs, of young insects, of winged insects; ravages of locusts east of Mississippi; nomenclature; prairie fires; locusts as food; fasting and prayer, etc.

*C: V. Riley. The Rocky Mountain locust. < American Naturalist. 1877. v. 11, p. 663–673.

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[Hagen, II, 339.]

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p. 117. La langosta.

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ERRATA.

Page 97, in heading, for "chonology" read "chronology."
Page 177, in heading, for "eastern" read "return."
Pages 183–203, in heading, for meterology" read "meteorology."
Page 130, line 2 from bottom, for "grapes" read "grasses."
Page 180, line 10 from bottom, for "they" read "there."
Page 431, table for Breckenridge, Oct. and Nov., 1875, for "0 and 0" read "10 and 6," respectively.
Page 431, line 2 from below, for "their number" read "these numbers."
Page 432, line 7, for "initial column" read "vertical columns."
Page 432, line 15, for "data....that" read "dates....those."
Page 75, Abbe at Omaha, August, 1868; and again August 13, 1869.
1868. Saw many locusts flying and lighting; garden much damaged; saw thousands of them ovipositing a few miles out of town.
1869. Saw some, but only very few.
1869. Was in Southeastern Dakota Aug. 5–10, and saw no 'hoppers.
Page [72], line 24, after "broomweed" add "(*Gutierrezia microcephala*, Gray)."

EXPLANATION OF PLATE I.

Unless otherwise stated, all the figures are enlarged, the increase in size usually indicated.

FIG. 1.—*Caloptenus spretus*, newly hatched, or in first larval stage, from side; 1 *b*, same, while yet pale, from above; 1 *a*, antenna of same.

FIG. 2.—Second stage; 2 *a*, antenna; 2 *b*, thorax, from above; 2 *c*, thorax, from side.

FIG. 3.—Third stage; 3 *a*, antenna; 3 *b*, thorax, from above; 3 *c*, thorax, from side.

FIG. 4.—Fourth stage, or first pupal stage; 4 *a*, antenna; 4 *b*, thorax, from above; 4 *c*, thorax, from side.

FIG. 5.—Fifth stage, or true pupa; 5 *a*, antenna; 5 *b*, thorax, from above; 5 *c*, thorax, from side; 5 *d*, pupal exuviæ, or last skin shed.

FIG. 6.—Sixth stage, or mature insect, the figure showing a typical male from the Permanent breeding-grounds; 6 *a*, smaller form, as hatched in the lower and moister country, where the species is not indigenous—natural size.

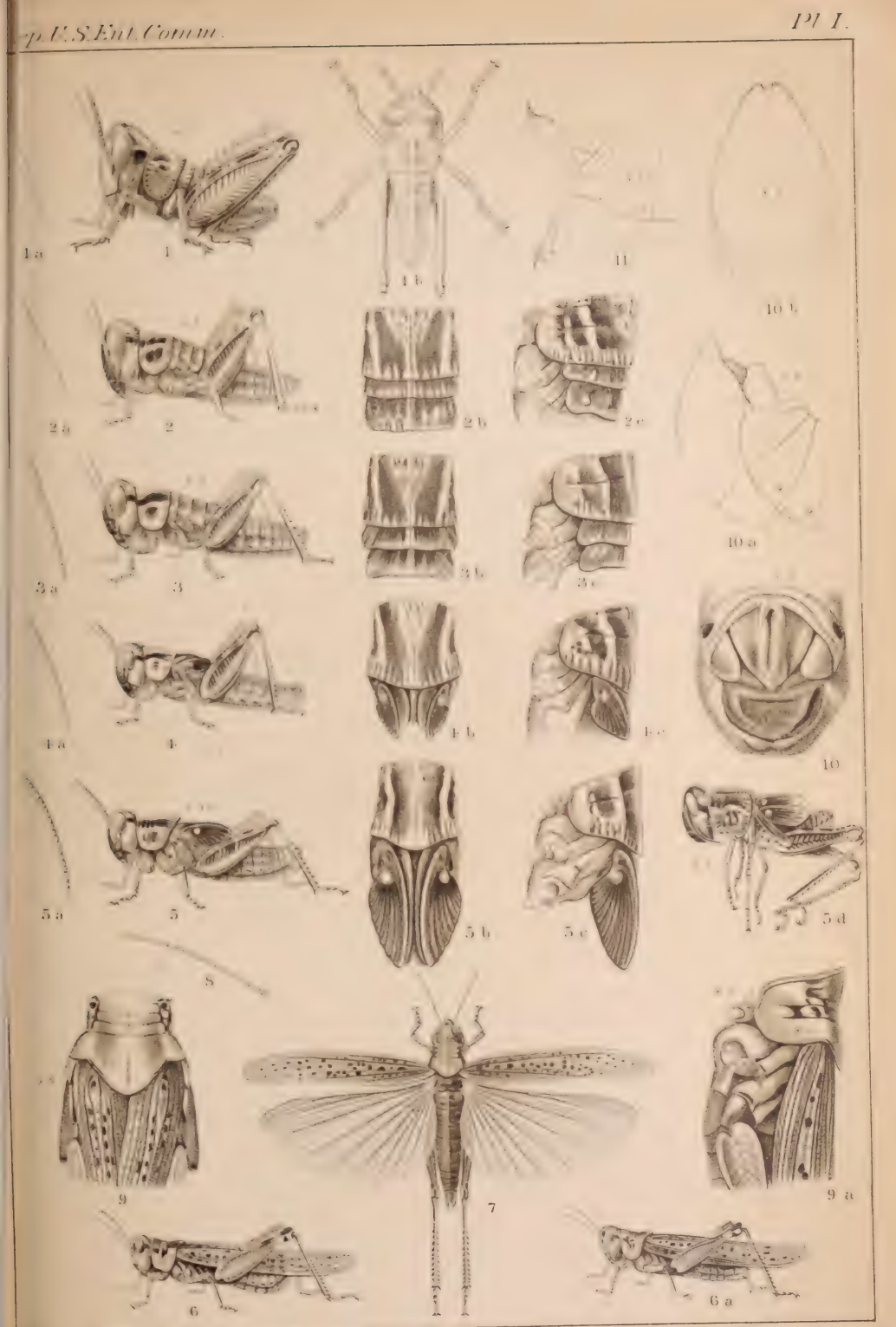
FIG. 7.—Typical female, with wings expanded—natural size.

FIG. 8.—Antenna of mature insect.

FIG. 9.—Enlarged thorax of mature insect, from above; 9 *a*, same, from side.

FIG. 10.—Anal characters of male, from above; 10 *a*, do., from side; 10 *b*, do., from behind.

FIG. 11.—Anal characters of female, from side.



Drawn by J. H. Emerton

A. Hoen & Co. Pht. Lithocaustic Balto.

ROCKY MOUNTAIN LOCUST.

(Caloptenus spretus)

EXPLANATION OF PLATE II.

Unless otherwise stated, all the figures are enlarged, the increase in size usually indicated.

FIG. 1.—*Caloptenus femur-rubrum*, newly hatched, or in first larval stage, from side; 1 *b*, same, while yet pale, from above; 1 *a*, antenna of same.

FIG. 2.—Second stage; 2 *a*, antenna; 2 *b*, thorax, from above; 2 *c*, thorax, from side.

FIG. 3.—Third stage; 3 *a*, antenna; 3 *b*, thorax, from above; 3 *c*, thorax, from side.

FIG. 4.—Fourth stage, or first pupal stage; 4 *a*, antenna; 4 *b*, thorax, from above; 4 *c*, thorax, from side.

FIG. 5.—Fifth stage, or true pupa; 5 *a*, antenna; 5 *b*, thorax, from above; 5 *c*, thorax, from side; 5 *d*, pupal exuviæ, or last skin shed.

FIG. 6.—Sixth stage, or mature insect, the figure showing a typical male—natural size.

FIG. 7.—Typical female, with wings expanded—natural size.

FIG. 8.—Antenna of mature insect.

FIG. 9.—Enlarged thorax of mature insect, from above; 9 *a*, same, from side.

FIG. 10.—Anal characters of male, from above; 10 *a*, do., from side; 10 *b*, do., from behind.

FIG. 11.—Anal characters of female, from side.

Drawn by J. H. Emerton.

Photo-electrotype Bolton.

RED-LEGGED LOCUST.

(Caloptenus femur-rubrum.)

EXPLANATION OF PLATE III.

Unless otherwise stated, all the figures are enlarged, the increase in size usually indicated.

FIG. 1.—*Caloptenus atlanis*, newly hatched, or in first larval stage, from side; 1 *b*, same, while yet pale, from above; 1 *a*, antenna of same.

FIG. 2.—Second stage; 2 *a*, antenna; 2 *b*, thorax, from above; 2 *c*, thorax, from side.

FIG. 3.—Third stage; 3 *a*, antenna; 3 *b*, thorax, from above; 3 *c*, thorax, from side.

Fig. 4.—Fourth stage, or first pupal stage; 4 *a*, antenna; 4 *b*, thorax, from above; 4 *c*, thorax, from side.

FIG. 5.—Fifth stage, or true pupa; 5 *a*, antenna; 5 *b*, thorax, from above; 5 *c*, thorax, from side; 5 *d*, pupal exuviæ, or last skin shed.

FIG. 6.—Sixth stage, or mature insect; the figure showing a typical male—natural size.

FIG. 7.—Typical female, with wings expanded—natural size.

FIG. 9.—Enlarged thorax of mature insect, from above; 9 *a*, same, from side.

FIG. 10.—Anal characters of male, from above; 10 *a*, do., from side; 10 *b*, do., from behind.

FIG. 11.—Anal characters of female, from side; 11 *a*, anal characters of female, from above.

LESSER LOCUST.

(Caloptenus atlanis)

EXPLANATION OF PLATE IV.

All the figures enlarged unless otherwise stated, the hair-lines indicating the natural sizes.

FIG. 1.—Egg-pod of *Caloptenus differentialis*, with the mouth torn open, exposing the newly hatched larva of *Epicauta vittata* (1 *a*) eating into an egg, and the passage which it made through the mucous covering—natural size.

FIG. 2.—Dorsal view of the *First larva*, or triungulin, of *E. vittata*; 2 *a*, one side of the head of same from beneath, greatly enlarged, so as to show the mouth-parts; 2 *b*, terminal joint of maxillary palpus, showing imbrications and flattened inner surface armed with stout points; 2 *c*, leg, showing more plainly the tarsal spines; 2 *e*, labrum; 2 *d*, one of the abdominal joints, from above, showing stout points, stigmata, and arrangement of spinous hairs.

FIG. 3.—Eggs of *E. vittata*, the natural size indicated at side.

FIG. 4.—Dorsal view of the Carabidoid stage of the *Second Larva* of *E. vittata*; 4 *a*, its antenna; 4 *b*, its right maxilla; 4 *c*, its leg; 4 *d*, side view of the larva, showing its natural position within the locust-egg mass.

FIG. 5.—Lateral view of the Ultimate or full-grown stage of the *Second Larva* of *E. vittata*; 5 *a*, portion of the dorsal skin, showing short setaceous hairs.

FIG. 6.—Third head, or that from the Scarabæidoid stage of the *Second Larva* of *E. vittata*, from beneath, showing the reduction of mouth-parts as compared with the first head (2 *a*); 6 *a*, antenna of same; 6 *b*, maxilla of same; 6 *c*, mandible of same.

FIG. 7.—Fourth head, or that of the full-grown larva of *E. vittata*, from above; 7 *a*, leg of same; 7 *b*, the breast-plate or prosternal corneous piece.

FIG. 8.—Lateral view of the pseudo-pupa or *Coarctate Larva* of *E. vittata*, with the partially shed skin adhering behind; 8 *a*, dorsal view of same; 8 *b*, its head, from the front; 8 *c*, same, from side; 8 *d*, tuberculous leg; 8 *e*, raised spiracle; 8 *f*, anal part of same.

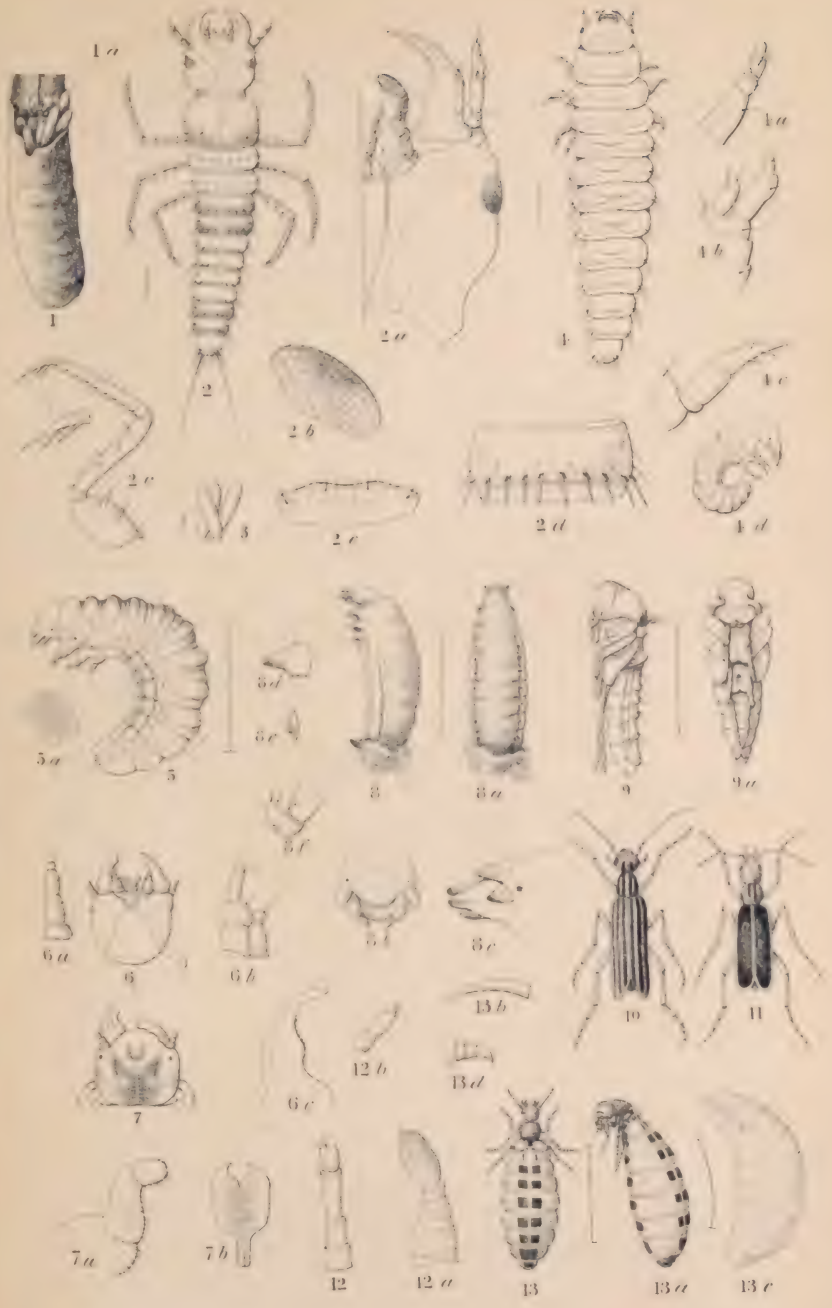
FIG. 9.—Lateral view of the true pupa of *Epicauta cinerea* Forst.; 9 *a*, ventral view of same.

FIG. 10.—*Epicauta vittata* (*lemniscata* or trivittate var.).

FIG. 11.—*Epicauta cinerea* Forst. (= *marginata* Fabr.).

FIG. 12.—Antenna of the triungulin of *Epicauta pennsylvanica*; 12 *a*, maxilla of same; 12 *b*, labial palpus of same.

FIG. 13.—♂ *Hornia minutipennis*, dorsal view; 13 *a*, lateral view of same; 13 *b*, simple claw of same; 13 *c*, *Coarctate Larva*; 13 *d*, leg of Ultimate stage of *Second Larva*



C.E. Bailey del.

Hypermetamorphoses of Epicauta and Hornia.

EXPLANATION OF PLATE V.

FIG. 1.—Longitudinal median section of *Caloptenus femur-rubrum*, female, to show the course and divisions of the digestive canal; *M*, mouth; *Oe*, œsophagus; Cr^1, anterior, Cr^2, posterior part of crop; *P*, proventriculus; *Div.*, blind sack or diverticulum of the stomach; *ven*, ventricle; *Il*, ileum; *Col*, colon; *R*, rectum; *An*, anus.

FIG. 2.—Optical section of Malpighian tube.

FIG. 3.—Section of the epithelium of the rectum of *Caloptenus spretus*.

FIG. 4.—Transverse section of the hind part of the crop; *s s*, spines of the cuticula; *rid*, ridges; *L*, longitudinal; *muc. C*, circular muscular coat.

FIG. 5.—Epithelium of the ileal folds; *A*, middle of folds; *B*, furrow between folds; *L*, longitudinal muscular band.

FIG. 6.—Epithelial cells of the gastro-ileal valve of *Œdipoda sordida*.

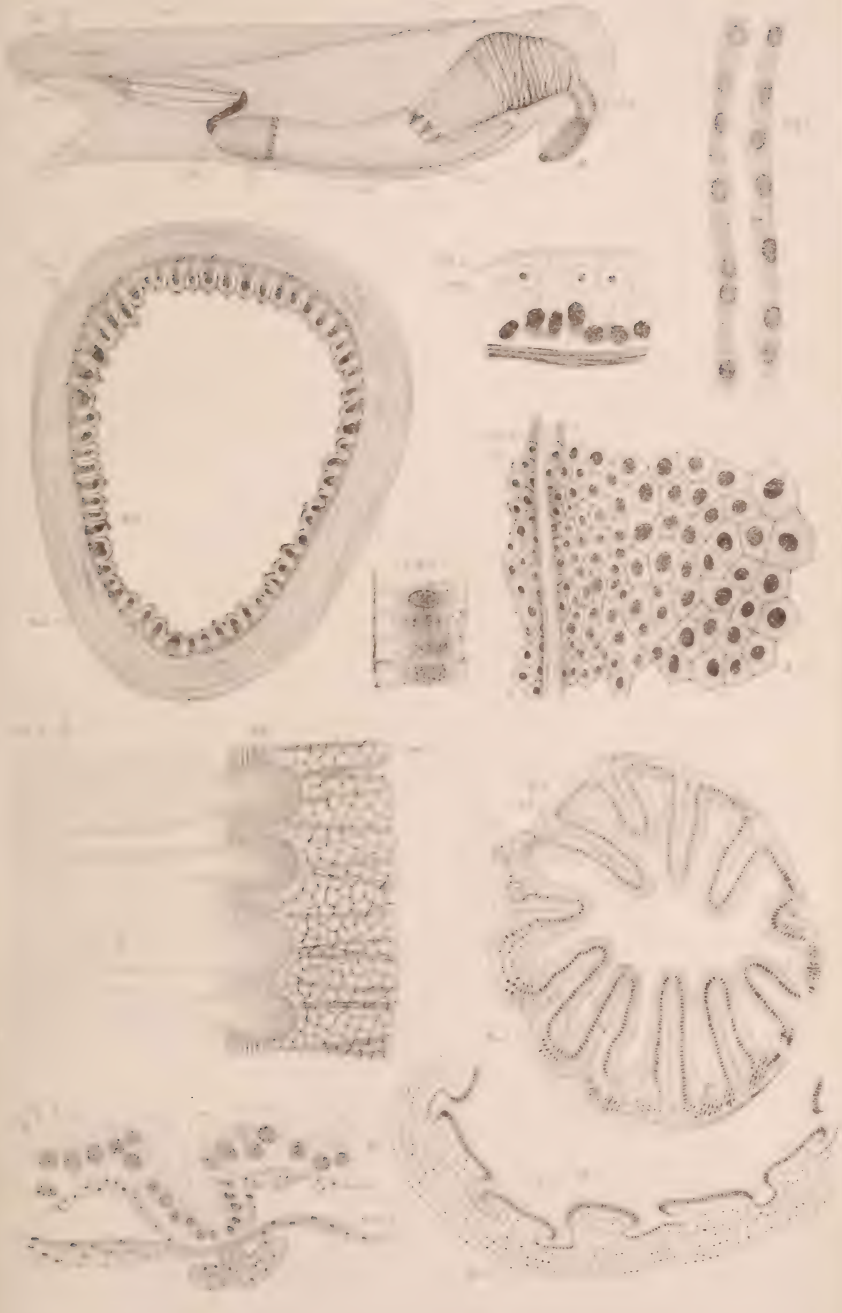
FIG. 7.—Surface view of the gastro-ileal valves; *Ven*, ventricle; *Bd*, circular muscular band underneath the folds; *Il*, ileum.

FIG. 8.—Transverse section of a diverticulum; *Tr*, trachea; *muc*, circular muscular coat.

FIG. 9.—Transverse section through the furrow; *F*, between two ileal folds; *cu*, cuticula; *Ep*, epithelium; *conn*, connective tissue; *muc. C*, circular muscles; *L*, longitudinal muscular bands.

FIG. 10.—Transverse section of the gastro-ileal folds of *Œdipoda sordida*; *muc*, muscular band, *Bd*, of Fig. 7.

NOTE.—For the permission to use this plate we are indebted to the publishers of the *American Naturalist*, where it first appeared in June, 1878.



HISTOLOGY OF THE LOCUST.

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